Binder.

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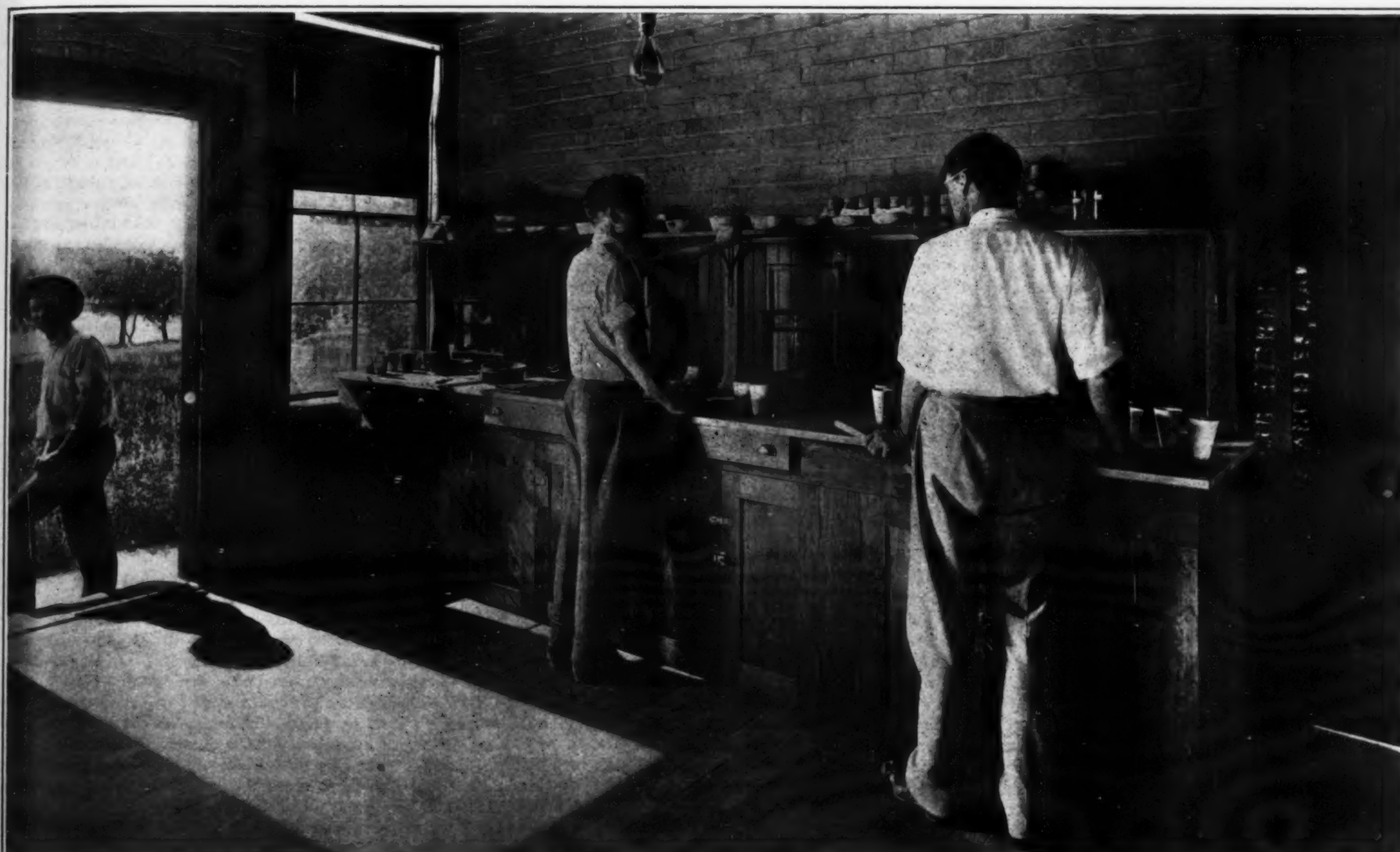
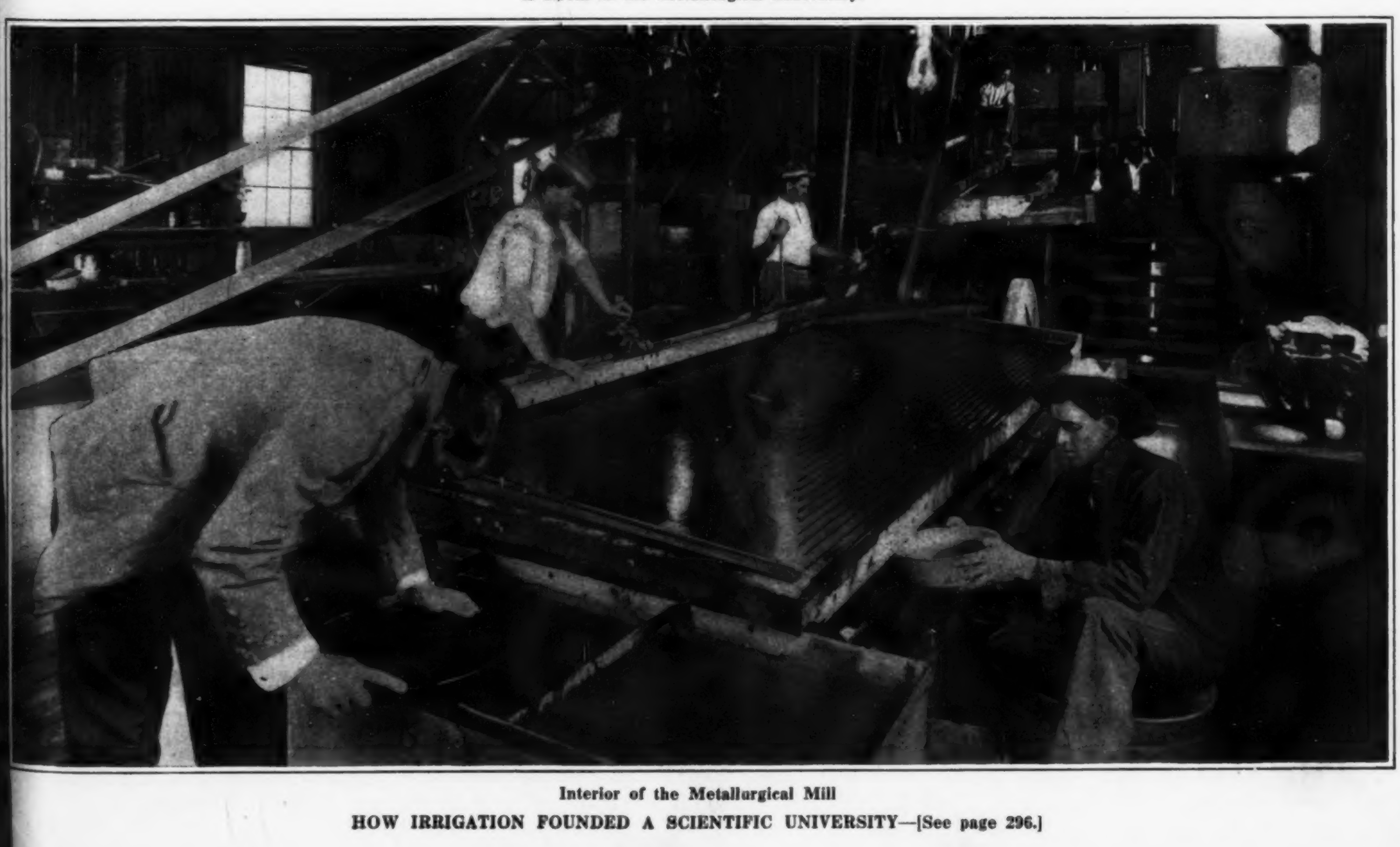


A Room in the Metallurgical Laboratory.



Interior of the Metallurgical Mill

HOW IRRIGATION FOUNDED A SCIENTIFIC UNIVERSITY—[See page 296.]

Energetics and Cultural History*

A Chapter of Ostwald's Philosophy

By Henry Hess

Instead of regaling or wearying you with a recital of my own views or work, I crave your indulgence in laying before you some matter taken from a recent work in German by that dean of our profession, Dr. Wilhelm Ostwald, "Die Forderung des Tages"—"The Demand of the Day." It is true that Dr. Ostwald is more generally known as a chemist, creating and marking an epoch, and as an inspiring teacher, and that he would, therefore, not generally be considered a dean of engineers, yet true engineering in its widest sense was a decidedly fundamental activity of his. The particular essay that so profoundly impressed me that I wished to gain your appreciation by bringing it before you was Ostwald's lecture on "Energetics and Cultural History." Were its author a writer aspiring to the older distinction of the classic culture, I should hesitate to thus crib, but engineers are broad-minded, and desire only to give the widest spread to their discoveries and teachings; let that be my apology.

Ostwald defines energetics as that scientific conception which considers the physical idea of energy as the one which, for the time being, presents the most exact gathering of physico-chemical facts and laws. Dr. Grechen pointed out that energetics is first a theory of physical phenomena, and that a connection of its results and methods of thought with the problems of the higher mental life is not immediately apparent. Energy, as the term is to-day scientifically defined, has but a loose connection with the moral quality of the same name. To the engineer, energy is a physically measurable quantity, best known to us as mechanical work. As chemistry teaches that coal, graphite, and carbon all represent the same substance, carbon, insofar as each of these may be changed into the other, so does physics teach that mechanical work may be changed into heat, light, electricity, chemical effects, etc. As impossible as it is to increase or decrease a given quantity of carbon by the most complicated transformations, so impossible is it to increase or decrease a given amount of work by the most intricate transformations. For both there rules the law of conservation. That which we can neither create nor destroy we call a substance; thus the chemical elements have the character of substances, as have also work and its transformation products. These latter are given the common term "energy," while the science of the laws governing the manifold transformation of energy is "energetics."

Prefacing that this is all well known, Ostwald answers the question for the reason of this repetition by the statement that these laws not only regulate, but even make possible, our very existence. Life is based on a continual change of energy in our body; with the instant of interruption of this change death ensues. But not only individual life, but all social life also, is directly dominated by the laws of energy. That a speaker may appear before you is due to the energy of some means of conveyance; that you hear a speaker is due to the energy conveyed from his vocal cords to you in sound waves; that you understand a speaker is based on the energy of your own mental activity. That is why we must, first of all, be practicers of energetics, long before we may choose any other view of the world—*why nothing may happen without the participation of energy in various forms!*

While the fact of energy is an every-day one, with the term not nearly so well known, the condition is exactly reversed as to culture. The word is generally familiar, but an agreement between any two or three educated people as to a definition will be hard to secure. There are many definitions of this term which it would seem impossible to give a common denominator. But the usefulness of energetics will show itself in its ability to embrace all of the many sides of the cultural problem. All life, individual as well as social, utilize those forms of energy that it comes into contact with for its own purposes by suitably transforming them. The result of this transformation may be great or little, as compared with the energy expended, much as a skilled artisan may, in a given time, do tenfold the work of an unskilled one. Ostwald makes the extremely significant assertion that the *measure of culture is the efficiency of transformation of raw energies to human purposes.* As the teachings of the schools have robbed most of us of an untrammeled vision, an explanation and a justification are in order:

All ancient culture was based on the existence of slavery. Only through it could a few acquire that leisure and the means essential to free scientific pursuits. This resulted in the involuntary equation of possession of slaves with high mentality, and the despising of all technical work as fit only for slaves. But the ancients themselves disproved this original hypothesis, since among the chief furtherers of culture there were found more and more slaves and freed men, because culture is based on *work*, technical as well as mental; between these two also the difference grows increasingly less.

If we can imagine ourselves back into the probable initial condition of human development, we see before our mental vision a being that is not superior to its surroundings by either strength, speed, invulnerability of covering, or otherwise advantageously fitted for the fight for existence; it is also not guarded against dying out by such protection as is found in a particularly simple organization or by great fecundity. *A single quality differentiates this being from others, that of increasingly freeing itself from the influence of changing conditions of existence by the formation of new, or the intentional retention of old, beneficial conditions.* It is this quality that finally gave to this weakly and poorly fecund race the dominance of the earth. Wherein lies the essence of this advance? What is the basic principle involved? Ostwald answers his question that *man learned to apply one transformer of energy after another,* using and bending to his purposes first the native energy of his own muscles, then that of other men (slaves), of animals, of plants, and finally the anorganic energies (wind, ground wealth, water power). The *possession of energy* in the sense of physical energy or the generalized idea of work *means the domination of the world.* If, to-day, more than ever before, the ownership of mobile capital carries with it this domination, it is because capital represents the most concentrated and most readily transformable form of energy.

It is often said that man acquired the domination of the world by his reason, and that reason carries with it the concentration of great power in the individual. This is true so long as reason is directed to acquisition of energy and its purposeful employment. Chess certainly does call for the exercise of considerable reason, and a champion certainly does develop much reasoning power when playing a game with a worthy opponent. But this is not directed to the energy problem, and is, therefore, foreign to culture; the latter would probably be greater, rather than less, did nobody play chess.

When some primitive man first found that using a broken tree limb enabled him to strike an opponent, animal or man, before that opponent could close with him, the first step was taken in the path of purposeful transformation of energy.

Purely mathematically the inclusion of the weapon (tool) did not permit the full application at the intended place of the entire muscular energy used. But the lesser absolute amount was compensated for by a more efficient application. Whereas the forefather of this inventor had to pay for each bear choked with the bare hands by wounds and days or weeks of inability to work, the cudgel wielder could kill his bear without being even scratched, and saved himself the days of nursing. He was, therefore, able in the same time and with the expenditure of the same amount of energy, to kill far more bears than his *brave* ancestor, who did not know how to transform his muscular energy by use of the cudgel.

The same may be said of each advance in culture; that is, either a more useful transformation of personal bodily energy, or the economic utilization of foreign energies for personal account. The first step in this second direction is undoubtedly the utilization of the man power of others, first having learned to direct and form that to one's own will. This brings before us for the first time the remarkable fact that by energy of higher grade lesser energies are dominated, even though the absolute amount of the subjugated far exceed that of the dominant energy. More remarkable still, all uprisings of slaves have ended in fiasco; in other words, all attempts to make absolute energy amount dominate have failed because these raw energies lacked organization. Only from the union of rising classes with ruling classes, where, therefore, the raw energies were organized, did lasting forms result. So it was in the history of the ancient Roman Empire, and so must we read the history of the French Revolution, with its consequences, in which the intelligence and the organizing ability of the upper classes were still needed to make permanent that freedom of the masses acquired by mere brute strength.

Ostwald then develops the same thought through the beginning and progress of the utilization and domination by man of the animal and plant world. The traditional reverence of the mythical discoverer of fire shows that the enormous step in the regular utilization of anorganic energy was felt and realized in prehistoric days. But the period of the extended and systematic utilization of anorganic energy has but begun, and may be counted back over barely a century. It began with the introduction of the steam engine with the nineteenth century, is now passing through a new development period in the utilization of water powers that was first made feasible scientifically by electrotechnics, and will finally have to take up the problem of the utilization of solar energy, that is now but poorly solved by plants with an efficiency of less than 1 per centum.

The older point of view—that of the adherents of the older "classic" education or "culture"—would make the advance of mankind in the technical arts, and the material ease that in turn gave time for the practice of this culture, a result of the culture. This idea is abhorrent to the strict logician, as making a result produce itself. Ostwald has clearly pointed out the logical line of development. Refer back again to the existence of a high classic culture as based on the leisure due to slavery, and then to the almost total loss and extinction of this culture, and its renascence and far wider and more general distribution as a result of the application of mental effect to the despised handiwork and brain work of the technician and scientific worker. The old classic arts had but a hectic existence and an early death, because based on the subjugation of human muscular energy (slavery), much as the consumptive shows a complexion envied by those not recognizing it as a symbol of early decay.

The necessity for this order of development is clear, since the progressive dominance of the other energies to that of the anorganic ones demands an increasing faculty for abstract thinking, which can but be the product of a greatly advanced real culture. That others can work as we do is a thought easily grasped; but that an animal may be trained to work does not fail to astound every child—is, therefore, unexpected. That a piece of wood or coal may work was so far fetched an idea that it required thousands of years before the thought occurred to man. And the law of the conservation of energy, which first permitted a clear view of this vast field, and with that its dominance, is barely sixty-eight years old.

So far the advance of culture has been considered only in its more narrow technical sense. Is there also a connection with the social and political organization in families, races, and people, with the State and law? At first glance the question of energy would appear to have nothing to do with these matters, and this would be true were it only a question of the law of the conservation of energy. But what purpose do organization, law, state, and the various other social forms of mankind serve other than the increasingly useful utilization of the available energies? What else is the law but an arrangement which permits each individual to devote his energies to a useful purpose, without having to deflect a portion to defense from predatory neighbors?

Ostwald next follows the development of war and armies from the early mere aggregation of men depending upon their muscular energy, to the defeat and displacement by those first using animal energy (cavalry), to their defeat in turn through the utilization of more concentrated forms of energy, as in gun-powder, and to the change from loose aggregation to the present firm aggregation into a relatively small number of powerful nations, and then draws a parallel with capital.

Simultaneously, another form of energy concentration has developed power as "mobile capital." The energy masses that are to-day collected in this power exceed by far those concentrated in armies; money is more necessary for war than are soldiers.

As in the beginning of the organization of States, the clans were the real embodiment of concentrated energy, and the life of each State depended upon its ability to weld these clans into larger units without the former continually tending to defect, we are to-day confronted by capitalistic organizations, with individuals and small unions striving to secure the benefits to themselves. Whereas no State to-day would tolerate an individual person maintaining at his personal disposition a body of armed men, the State does tolerate the concentration of the infinitely greater might of mobile capital in the hands of the individual, making it possible for him to levy tribute on the entire world. Ostwald here points to the monopolization of petroleum by Rockefeller, to hinder which the President of the United States even does not appear to possess adequate power.[1]

The condition is about the same as toward the close of the middle ages, when the leaders of the mobile free-lance soldiery were practically the rulers. Necessarily, the newer development will have to follow a similar path, as the State must itself, in self-defense, undertake the concentration of capital and thus utilize its resultant immense energies for the best interests of its citizens. It is true that this will necessitate the disappearance of the

* Presidential address delivered before the Engineers' Club of Philadelphia, and published in its *Proceedings*.

[1] This was written in 1909, before the recent settlement (?), by dissolution, of the Standard Oil Company.

superstitious fear of the interference of the State with private possessions, a Pandora's gift handed down to us, with a choice collection of others, from the old Roman law.

Concentration of capital in the individual has proved itself to mean the most intense possible conversion of the raw energies (mineral, etc., wealth) that the individual or individualistic group controls, into capital energy, without regard to their rational utilization in the interest of the entire community. The concentration of capital in the hands of the State, carrying with it the control of all of these raw energies, substitutes for their conversion in the selfish interest of the few their utilization in the interest of all. We must not consider the ideal of our development the using up, in the shortest possible time, of our surely limited treasures, but find our pride in satisfying our cultural needs with the least possible using up of our raw energies, and not forget the purpose of our life over its means.

Having grasped the significance of this idea of physical energy, its central relation to the extraneous, economic, and social side of human culture may be granted; but can it be applied also to art and science, these highest blossoms of our culture? The answer does not seem doubtful. Quite aside from this much-debated question of psychic energy, it is clear that art and science must be carried on. To carry them on a bodily organization is necessary, the productivity of which depends upon many circumstances, among which a happy increase of productive ability is of chief importance. But this is possible only if the mental apparatus disposes of sufficient free energy. As an old man, Goethe complained much of the diminishing productivity of his later years; it was clear to him that this could not be forced. He, therefore, did his work in the early morning hours, having found that the lessened energy at his disposal in old age was not sufficient to overcome the distractions of the later day and permit other work. The highest work of genius, as all other work, reduces itself to a transformation of energy. It is merely a form of energy of great rarity and corresponding value into which genius converts the lower forms. Its high value again resides in the fact that it influences other men to the better conversion of their energy. The chemist knows phenomena of this character as "catalysis": an action that ordinarily takes place slowly, even unnoticeably, is incomparably quickened by the presence of a substance that finally comes out of the reaction itself unchanged and undiminished. That is the action of a work of art on a receptive mind: it does not increase the absolute amount of the existing energies, because energy cannot be created; but it does accelerate the rate conversion of the existing energies, and instead of purposeless dispersion, promotes their working together in harmony toward a valuable end. In this catalytic effect of art Ostwald finds the social value and significance of art; it is not only a purpose, but a means to an immensely valuable end.

The social economic value of science is even plainer by far. There is no such thing as science for its own sake (note the significance from a past master of science)—that would be mere play—no, science exists for human ends. Such phrases as idealism and utilitarianism are handy, not to disprove this statement, but merely to decry it for those without judgment.

Whoever follows science for narrow personal ends, to him she is but a milch cow. The sound-thinking and feeling man will enthusiastically follow science whenever he recognizes and feels its social value, be his branch whichever it may, when he sees that it makes it possible for him to lighten human burdens and increase human joys—in a word: to better mankind's utilization of its free energy. Take the most abstract science, logic. If ever there would seem to be a science so academic that it could be followed only for its own sake, this must be it. But a moment's thought will show that the development of logic may decrease the sum of human errors and so make clear the practical value of this science.

One may ask one's self whether any great amount of human discomfort and useless work may be saved by human endeavor. The true scientist will answer "Yes," and in that answer find the enthusiasm and persistence needed for creative work and real advancement of science. But he who has not this perspective, who does not find this *practical* viewpoint, will but hunt a "job."

Idealism is not a lack of purpose, as those who follow purposeless things would have us believe; on the contrary, it is the most intense knowledge of purpose; but the purpose must be set high enough to merit the name of idealism. And all these high purposes may again be viewed as the delivery of mankind of its burden and the enhancement of its joys. But relief from burden is a diminishing of energy used for a given purpose, therefore improvement in efficiency, while increase of enjoyment means increased activity of the nobler energies resulting from a freeing of a greater portion of the total energy for that purpose—in the end the same thing. We, therefore, inevitably arrive again and again at the same viewpoint, and must be convinced that we have found a scale for the measurement of every human endeavor.

The law of the conservation of energy, also, was first doubtfully accepted, even denied, but to-day we know that there is no physical phenomenon which may not be brought into a definite equation on the basis of this fundamental law.

Ostwald closes with the enunciation of a new law, deduced through a similar development of ideas that:

The measure of culture is the efficiency of the transformation of raw energies to humanly valuable purposes.

The Chemistry of Sewage Disposal*

Chemical Action the Basis of Every Successful Method

By George G. Nasmith

It is now the accepted theory that bacteria and other forms of life are invariably necessary in order to obtain fixed results from any method of sewage disposal. It is recognized that these work under more or less definite, fixed conditions, and demand certain treatment; that they can be governed to perform their functions efficiently, and, finally, in the performance of their work that they depend on a free supply of oxygen to completely oxidize the organic matter and create a non-putrescible effluent.

It came to be recognized that one could obtain all sorts of hydrolytic decomposition in septic tanks, or under anaerobic conditions, with productions of proteoses, peptones, amino acids, nitrites, hydrogen sulphide, methane and hydrogen; that these decomposition products were still for the most part putrescible, and sometimes more difficult to handle than the raw material from which they were derived, and that, after all, the complete end products of any method of decomposition depended on the fact that oxidization of carbon gave carbonic acid; of nitrogen gave nitric acid; of sulphur gave sulphuric acid, and of hydrogen, gave water. These are the final products obtained in any completely oxidized sewage. Sewage disposal in the chemical sense might be stated: Organic matter + Oxygen = Inorganic matter + Humus.

As the object of every method of sewage disposal is to create a non-putrescible effluent, and more recently a non-pathogenic effluent, the anaerobic methods, such as that of the septic tank, have failed because of this one fact, that the end products of anaerobic action are still putrescible, and must be further treated.

The real biological oxidation methods may be grouped together, since the action taking place in them all is practically the same. These are (1) Intermittent sand filtration, which really is an improvement on the older method of sand filtration; (2) Contact beds—single, double, or triple, and (3) Trickling filters.

In all methods of sewage disposal it is deemed advisable as a preliminary to remove as much of the suspended material as possible, by means of the various forms of sedimentation tanks.

Now, if the material is sterilized in any of these methods, no action, or only a very slight one, takes place. If the sewage is treated with disinfectants, the same thing occurs; but if these various types of beds are given repeated doses of sewage, the organic matter is gradually converted into inorganic salts, and the filter becomes matured. At the same time it is found that the sand granules, or stone, slag, or other material, becomes coated with a gelatinous layer containing bacteria, organic material and iron. As the gelatinous film becomes thicker, the purifying action is improved.

In such a matured, intermittent sand filter, Dunbar found that if a gallon of a solution of albumen was poured on to the top of the filter, a gallon of water, less the albumen, flowed out at the bottom. That this was the same water he proved by adding readily detected chemicals, such as potassium iodide or fluorescein to the original solution. When repeated at intervals he found that the sulphuric acid in the effluent corresponded almost exactly to the sulphur in the albumen, while only part of the nitrogen appeared as nitrate, the rest of the nitrogen disappearing as free nitrogen or remaining locked up in the humus, which was formed in small quantities. A portion of the carbon also disappeared as carbonic acid, while the balance was retained in the humus.

The remarkable fact, therefore, became apparent, that a solution of albumen or sewage may leave an intermittent sand filter thoroughly purified in ten minutes. In other words, the organic material in the sewage became absorbed by the gelatinous material covering the granules in the filter. It is known from experience that micro-organisms cannot decompose such material in a few minutes.

By excluding air from the filter, it was found that such purification ceased to take place. By sterilization of the bed, or when disinfectants were added to the sewage, purification also ceased. The principle became fixed that bacteria in presence of air were essential for purification.

It was then demonstrated that in a matured contact bed, if quantities of distilled water were added at intervals, there would be considerable quantities of nitrates found in the effluent, and carbonic acid would continue to be given off and found in the air of the filter. The conclusion was therefore very obvious. The organic matter was first absorbed by the gelatinous film, and during the periods of rest while in contact with the air, this was decomposed with the aid of organisms, during which process oxygen was used up, and fresh oxygen drawn into the filter. This latter fact has been proved with the aid of capillary tubes inserted into the beds and connected with manometers. If a contact bed is filled with sewage, and air is blown in at the bottom, the free, unabsorbed oxygen is unable to carry out the necessary oxidizing action, and the sewage is not rendered non-putrescible. The oxygen thus absorbed during intervals of rest seems to be condensed on the surface of the gelatinous film, into some more active form, possibly as ozone, by the high pressure which is known to exist in such gelatinous films.

In the trickling filter, the principle of oxidation has been carried to its logical conclusion. In such beds, the sewage is continuously sprayed over the surface by one of the innumerable devices for the purpose. The bed itself is composed of some hard material, preferably of slag, which does not readily weather, and is so arranged that the filling material becomes smaller toward the top and larger toward the bottom, so that humus-like substances formed may be readily washed away.

Sewages which could not be treated satisfactorily in contact beds were handled satisfactorily by simply trenching the surface of the bed, placing a layer of sand along the bottom of the trench, and allowing the sewage to flow along these trenches, the raised parts allowing free access of oxygen. The contact beds were thus converted into trickling filters, and the results were eminently satisfactory.

The septic tank, which is wrong in principle, except in so far it may prove useful as a liquefying agent, is already doomed as an integral essential to any method of sewage disposal.

The contact bed, which is on a right principle, wrongly carried out, will also probably soon disappear. The intermittent sand filtration method, which is satisfactory in principle, is very expensive to construct and maintain for a given unit of sewage treated.

Based on purely theoretical principles, and with the experience already gained, in point of economy and efficiency, there is no doubt but that the trickling filter has come to stay and is bound to displace all present forms.

The sedimentation of the humus-like material from a trickling filter is readily accomplished, and should constitute part of the system in order to obtain a clear effluent suitable for disinfection with chlorine, as well as to remove an obvious physical objection.

The disinfection of raw sewage by chlorine may prove a valuable compromise in some rare instances when other methods of treatment are not possible, but is said to be not working out as well as was expected. It should prove of great value in rendering a clear effluent from biological sewage disposal systems absolutely safe.

* Reproduced from the *Engineering Magazine*.

Manganese in Steel Production.—Ferro-manganese is best added to steel in the heated state, as if it is put in cold it causes a cooling down of the metal and more ferro-manganese is needed than theory requires. Besides the mixture lacks in homogeneity. It is thus desirable to melt the metal, but much of it is lost by volatilizing in this case. In Germany a very good method is now used, the ferro-manganese being melted in a Keller electric furnace at the Burnbach steel works. The cost of melting the 4,000 tons of ferro-manganese needed for treating 800,000 tons of steel is found to be $20,000 at the present rates for current (an electric melting furnace being used), but much economy is secured by the fact that there is scarcely any loss of the metal, which is now employed in the melted state, so that less of it is needed. Supposing that the amount is lessened by two pounds per ton, this gives a saving for 800,000 tons of steel of 800 tons of ferro-manganese, which valued at $40 a ton figures out to $32,000.

Fig. 1.—Printed Cloth Bindings Contain Oils and Greases That Attract Insect Pests.

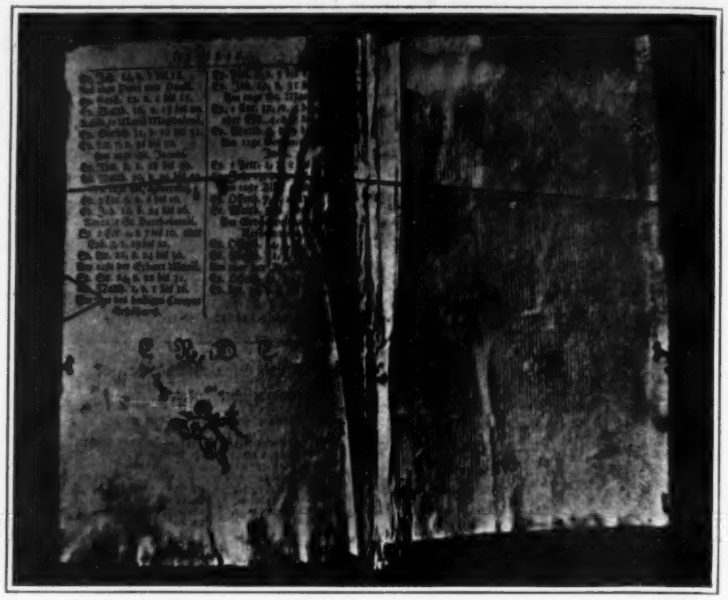


Fig. 2.—Books Bound in Wood Covers are Subject to Attack by Insects Native in the Wood Employed.

Insects Destructive to Books*

Some of the Pests that Play Havoc With Our Libraries

By William R. Reinick

Second Contribution[1]

It will be impossible in this lecture to go into details regarding the various series of experiments that have been made and studied in order to obtain the results, which I will speak of this evening, on account of the limit of time. Some of my remarks will appear to some researchers to be the words of one lacking an understanding of the groundwork of science, but in reply to those who doubt, I can only say, investigate along the same lines and the results will amply repay you for your time and labor.

Paste-eaters.—The statement previously made by me to the effect that the paste used in binding was often eaten by the larvæ of insects hatched from eggs that were originally in the flour, has been questioned on the ground that the heat necessary to boil paste, 212 degrees, would have killed all life. How this challenge could have been made by anyone who had experimented on the vitality of eggs under adverse conditions is beyond my comprehension. They confuse the life that has hatched with the life within the egg. Heat no doubt would destroy the greater portion of the life that had hatched, but not always, as in the case of certain bacteria, who from their known power to withstand a high degree of heat, are popularly called heat-lovers. They have even stood the high temperature of steam for a number of hours. But aside from the imago state of the insect, the egg, in which the embryo passes through its various stages, has been overlooked, and experiments properly conducted will prove them capable of withstanding a temperature very much above that which the scientist of to-day has knowledge.

Anyone caring to investigate the life in the paste may easily do so in the following way: Boil the flour in the usual manner, adding the glue for the binder, and after allowing the mass to cool, let stand in a dark, damp place. After it has become sour, it will be found that nature will again produce the same forms from it as she did when it was in the form of flour. Naturally, to give conclusive evidence, care must be taken to see that no insects are allowed to gain access to the paste from the outside, so as to avoid any possibility of their laying their eggs in the substance.

Bindings: Wood Bindings.—Books that are bound with wood covers are always subject to the borings of the insects that lived on the species of trees from which the boards are made, especially if the atmosphere is saturated with moisture, this being due to the porous nature of the wood. (Fig. 2.) Take the point of a needle, touch the wood, and you find that it gives, showing that it is composed of cells containing gases. They are not only subject to attacks from without, but also from within, i. e., larvæ hatching from eggs that were deposited in the tree before it was made into lumber. The early stages of a number of species of wood-destroying insects take quite a long period to evolve.

The insects destroying wood bindings are species of *Bostrychidæ* and some of the *Scolytidæ*. (Figs. 4 and 5.) One species of *Cerambycidæ* has been named as causing trouble, and as a large proportion of the species of this family are wood-borers, other species will likely be found to tunnel these covers.

Bindings: Leather Bindings.—The so-called dry rot of leather bindings said to be caused by the fumes in the air, especially where gas is used for lighting purposes, is also found to take place with leather-bound books that have not been exposed to such chemicals. Investigation will prove that instead of gases being the destructive agency, minute forms of life alone are the cause.

Another subject for future research is the cause of certain round holes, as though made by shot, often found in books bound in sheepskin. A careful examination of bindings showing these peculiar shot-like holes failed to show any galleries leading into or along the back of the books, which the *Coleoptera*, the insects named as committing these ravages, would make; and careful observation will reveal that instead of the holes being made by beetles, that a species of *Trichina*, a parasite which at present causes great losses to sheep-breeders, is the source. The skins, even after going through the various processes of tanning, still contain the same basic principles as in the primal state.

Bindings: Printed Cloth Bindings.—These bindings, on account of the oils and greases used in their manufacture, are subject to the ravages of those insects which have use for such substances. (Fig. 1.)

Species of *Blattidæ* (Fig. 6) and *Gryllidæ* are fond of these bindings.

Printing Inks.—While investigating the various printing inks, Mr. Thomas A. Bradley, President of the Security Bank Note Company of Philadelphia, called my attention to the fact, that the working clothes of the employees of his company, if left hanging in a dark place for a time, were found to have been gnawed by the larva of some species of insect, and that the most striking part was, only that part of the clothing which had been stained with ink was eaten. Most inks contain one or more acids in their composition, and as they are claimed to be poisonous and therefore should kill, one would say that the parts of the goods discolored by the inks should be exempt from these attacks, instead of proving attractive. A French author writes of a book in which the insects had eaten the portion of the paper which had received the impress of the ink, showing that they were after something besides the paper, paste or binding.

To prove this, I took a piece of parchment—sheepskin and imitation—and a quantity of the finest grade of engraver's black printing ink, made a circle of ink in the center with diagonal lines running from this to the corners and sides and a one-eighth inch border all around the edges. After the ink was dry, I placed a piece of each kind of parchment in a tin can with twelve roaches, adding water from time to time for drinking purposes. At the end of two weeks an examination of the parchment showed that the roaches had eaten all of the edges, had then followed the diagonal lines, eating mostly the portions so marked, and then the circle, showing that they knew the value to them of the acetic acid which was in the ink.

I hope that other experiments will be made along the same lines to ascertain if the various dyes, though often of the same color, are more secure from the inroads of insects than others, on account of containing certain chemicals in their composition. *Blatta orientalis* was the species used in making these experiments.

Fig. 3.—Photograph of the Cover of a Book From the Land Office, Punjab, Showing the Work of Anobium Paniceum.

* Copyrighted by the author, 1911, and reproduced here by his special permission from the *American Journal of Pharmacy*.

[1] A lecture delivered at the University of Pennsylvania. The first contribution appeared in the Scientific American Supplement for December 24th, 1910.

CONDITIONS FAVORABLE FOR THE PROPAGATION OF BOOK PESTS.

Darkness.—The majority of libraries generally keep a large number of their books upon stacks placed in a dark portion of the building, badly ventilated, and the only light available as a rule is from gas jets or incandescent lamps, which are only lighted when needed. This darkness, the more or less damp air which is found in these surroundings, the gases of various kinds in the air, and the fact that the books most seldom called for are kept in these locations, all combine to give favorable conditions for the propagation of these small forms of life without much chance of their being disturbed during the evolution of their life-cycle.

UNFAVORABLE CONDITIONS FOR THE INCREASE OF THESE INSECTS.

Light.—This, and cleanliness, are the two most important factors in preventing the ravages of insects among books, and will also prevent another sort of damage to books, namely, the various kinds of fungi which start to grow upon and in the books a short time after they have been placed in a damp, warm atmosphere.

The lessening of the destruction of books that have been kept on shelves in badly-ventilated and badly-lighted libraries, after having been transferred to a new building having good ventilation and light, is ably illustrated by the experience of Mr. Ernest J. Reed, Librarian of the Oahu College, Honolulu, Territory of Hawaii. He stated in a letter to me that before the books were moved to the new building, the whole collection was constantly being riddled by various species of boring insects, but that since moving to the new quarters they are comparatively little troubled by pests. From an examination of samples of books I have received from him, I wonder how anyone was able to read the books with any degree of satisfaction, as many had hundreds of tunnels running through them, some had large cavities eaten in them, and others looked as though a mischievous boy had taken a pair of scissors and tried to see how many strips he could cut each leaf into; in others the cloth binding was almost entirely eaten off, exposing the galleries made by the beetles in the cardboard covers.

Books will also be found to have forms of life living upon them which at present cause much speculation as to what substance they feed upon, and the insects commonly known as book-lice, belonging to the family *Psoidæ* (Fig. 7) of the order *Corrodentia*, are examples. In turning over the pages of books or looking over papers which have been kept in a dark location for a long while, one with a keen eyesight will often see little specks of life run to a crevice to hide or get away from the rays of light. On account of their whitish gray color and an ability to run with a speed which is amazing when the size of the insect is considered, it is only the keen observer who will spy them as they scamper across the printed pages. Though so small, they will be found to be the cause of a great deal of damage to books.

Many investigators think that the greatest danger is committed by the larger forms, whereas, as a rule, the smaller species, in proportion to their size, consume many times the amount of food as compared to that of the larger insect. I especially noticed this in making the experiment on artificial parchment herein mentioned, where twelve roaches, many of them female, big with eggs, at which time, of course, in order to provide the necessary supply of food for the coming generation, they would eat more than before the period of gestation, ate such a small amount of the paper that I spoke about it to a gentleman who was present when I examined the parchment. A fly in one day will consume food equal to its own weight. This is also illustrated by birds, who, in proportion to man, eat a far greater quantity of food.

Researches.—During the past year, I have made a number of experiments, and much against my will have arrived at the conclusion that as far as our present knowledge of the effects of poisons on these small forms of life is concerned, we have not even laid the foundation upon which to build.

The potato bug is an example. The paris green is placed on the plant in the morning, but at night the bugs are still there and seem to be eating the plant with more voracity than when it was absent.

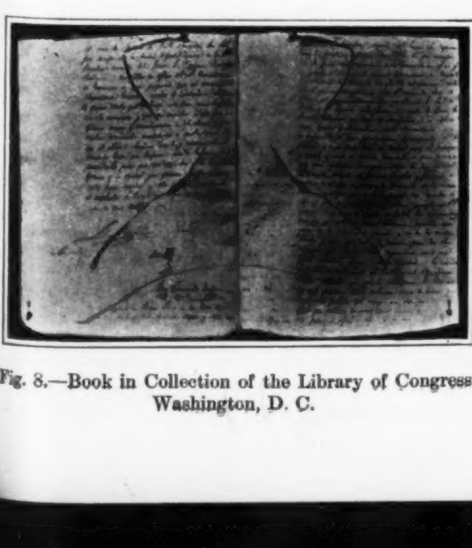


Fig. 8.—Book in Collection of the Library of Congress, Washington, D. C.

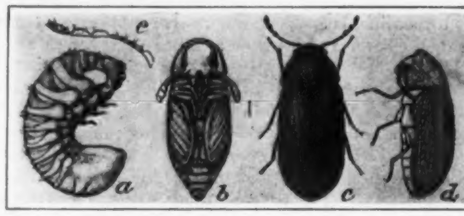


Fig. 4.—*Sitodrepa Panicea;* *a*, Larva; *b*, Pupa; *c*, Beetle, Dorsal View; *d*, Lateral View, All Much Enlarged; *e*, Antenna, More Enlarged.

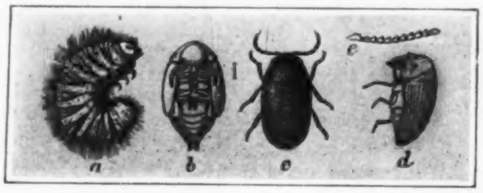


Fig. 5.—The Cigarette Beetle (*Lasioderma Serricorne*); *a*, Larva; *b*, Pupa; *c*, Beetle; *d*, Same, Lateral View, All Enlarged; *e*, Antenna, Much Enlarged.

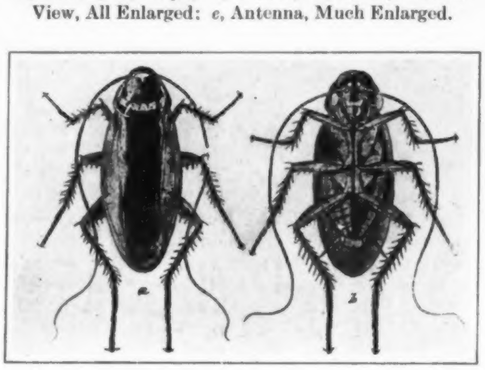


Fig. 6.—The American Roach (*Periplaneta Americana*); *a*, View From Above; *b*, From Beneath, Both Enlarged One-third.

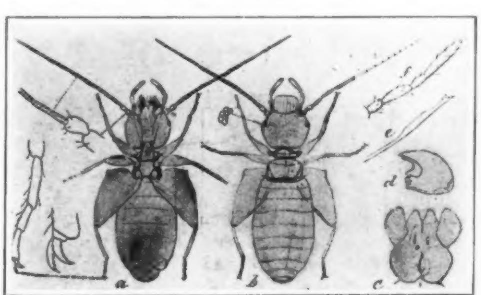


Fig. 7.—*Atropos Divinatoria;* *a*, Adult From Below; *b*, Same From Above; *f*, Maxillary Palpus; *e*, Maxilla (?); *d*, Mandible; *c*, Labium, all Enlarged.

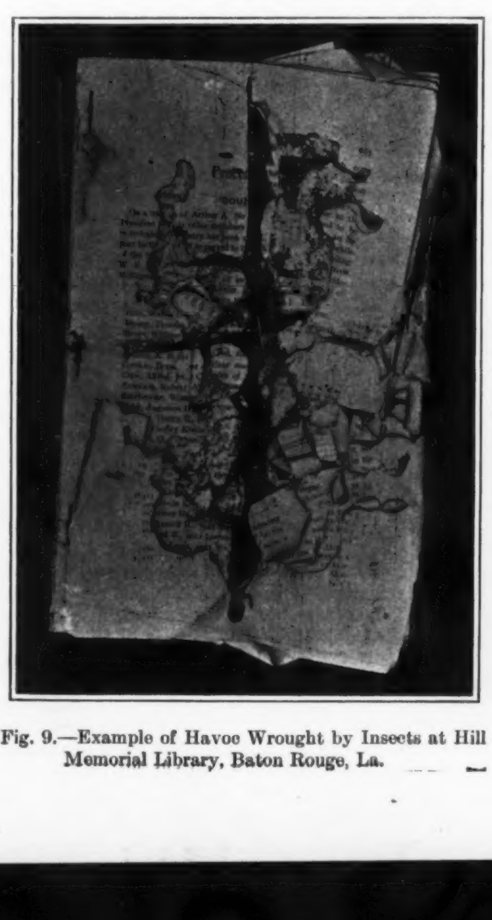


Fig. 9.—Example of Havoc Wrought by Insects at Hill Memorial Library, Baton Rouge, La.

Another source of error is the lack of positive knowledge as to the resistance of these minute forms to poisons, heat, pressure, etc., in their early stages. I have been taken to task for the statement made by me in my first paper as to mosquitoes hatching from eggs that have lain exposed for a long period of time, but I think that the following example of life remaining dormant under adverse conditions is more wonderful.

When I started to collect insects, I used for a cabinet a case of drawers which had been kept in a dry room of my home and had been in daily use for about twelve years, and placed it in an outside shed, the atmosphere of which was warm and damp. Some time after, upon looking at the contents of one of the drawers, I discovered a specimen of a large species of *Cerambycidæ* lying on the bottom and wondered where it came from. After searching on the outside and finding no opening, I pulled the drawer entirely out and discovered that the insect had emerged from the board used in making the side of the drawer, showing that while the case remained in a dry location, the life remained dormant, going on with its life cycle when the proper conditions were given.

Seeds stored in a dry location for quite long periods have been known to produce plants when placed in the soil, and anyone familiar with bacteriology knows the great vitality of these forms, invisible to the naked eye. The smaller forms also have bodies more capable of withstanding supposed remedies than the larger insects. Take one hundred roaches and the same number of red ants, pour boiling water on them, count the number of survivors of each kind, and you will find that all or mostly all of the roaches will have been killed, while a large proportion of the ants are still alive; an interesting line of experimentation for economic entomologists.

Remedies.—I have received letters from almost every country of the world suggesting remedies, some claiming success, but the majority acknowledging defeat; in many cases what was proclaimed to be a specific remedy by one writer was declared to be a failure by others.

Even books treated with the strongest poisons, failed to give the desired results, but on the contrary the remedies seemed to give the insects that they were supposed to kill a new lease of life. In the case of experiments conducted by the United States Bureau of Standards,[2] and also by myself, the roaches (the insects experimented with) produced their young as though nothing unusual was taking place. This Bureau made a very large series of experiments in order to obtain, if possible, a binding material which would be exempt from the inroads of insects, and also to witstand the effects of light and gases without fading, and which Dr. S. W. Stratton, the Director of the Bureau, very kindly loaned me for study. The tests were made with cloths, ducks and buckrams of various colors. A portion of each piece was chemically analyzed in order to find what substances were used in their manufacture, and the rest of each sample was exposed to the roaches for various numbers of days. The results, when tabulated, proved that it did not seem to make any difference as to what materials were used in the coating, many of which were poisonous, as they had nibbled all but one of the bindings. The effect was then tried of impregnating some of the samples with a weak solution of quinine and others with strychnine, but these failed to give the desired immunity; and, upon increasing the quantity of the poison in the solution, the attractiveness of the substance was increased. Even corrosive sublimate was ineffective. It is true that the insects died within a few days, but not until they had ruined the bindings. One sample, seeming to be exempt from their ravages, was selected and adopted by the Bureau as a standard for binding the United States Congressional documents, and also accepted by the American Library Association Committee on Book-Binding as the best binding for library books.

During a conversation in the Government Printing Office last winter, while being shown the various materials

[2] Memoranda relative to binding of publications for distribution to State and Territorial libraries and designated depositories.—United States Congress, Washington, 1908.

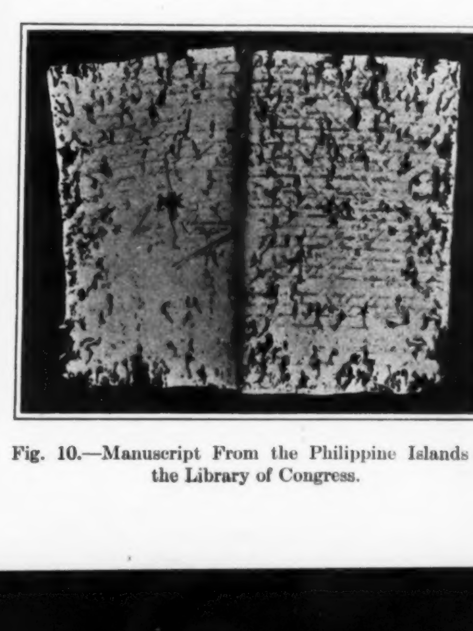


Fig. 10.—Manuscript From the Philippine Islands in the Library of Congress.

used for binding Government documents, I expressed doubts as to the buckram approved, known as No. 666, being insect-proof; and this opinion has since been confirmed by experiments made by the Philippine Bureau of Science, Dr. Stratton and myself.

My own experiments with a poison of an entirely different character gave better results. One-half of each of the various kinds of binding materials tested was treated with my preparation and the other half left untouched. They were placed in boxes and exposed to the attacks of the roaches for various periods. Upon examination, I found that while the coloring matter in certain samples had been eaten on both the treated and untreated portions, the poisoned portions of quite a number of the others were left alone. In some cases pieces of the same color, although of different manufacture as regards to one sample, were eaten and the other piece was left undisturbed. The remedy used by me did not, to my knowledge, kill any of the insects. From a comparison of the results, I arrived at the conclusion that the material used for coating the buckrams, etc., in a number of cases, had neutralized the effective action of the preparation used by me, and that in order to really obtain a material that would be insect-proof, it would be necessary to use such coloring matters as would not overcome the beneficial action of the poisons.

The fact that insects seem to show preference for certain colors used in binding materials, has already been noticed by a few of my correspondents; and also by myself while making researches in Florida last summer.

The Philippine Bureau of Science, finding that the buckram used as a standard was not insect-proof in the Islands, made another series of experiments, and have produced material which they claim is absolutely safe, but as I have not received any samples to test, although I have made request for same, I am unable to pass judgment upon it.

Although scientists have been experimenting upon binding materials in order to obtain one that would be exempt from the ravages of these little insects, little has been done toward preserving the most important part, and which, according to my investigations, receives the greatest injury, namely, the printed portion of the book. Some experiments made by J. Rodway, Esq., Secretary of the Royal Agricultural and Commercial Society of British Guiana, with papers impregnated with sulphate of copper, turpentine, kerosene and corrosive sublimate, failed to stop the borings of the insects. I have sent boards and books made of different papers which I have treated with a substance to Mr. Rodway, and to other parts of the world, and the results as to the effectiveness of the remedy used should be received during the coming winter.

Arsenic in its various forms is used in large quantities in the materials used in book-making, though denied by the manufacturers; but chemical analysis will generally show the presence of this substance, which is of use to the insects. The elimination of arsenic in materials used in book-making would not only do away with a source of attraction to the insects, but save people from being poisoned, as anyone familiar with the literature of poisons knows.

Books as Disease Carriers.—Again, I speak upon the transmission of diseases by books, because the greatest disease carrier among insects that we know of to-day is the common house-fly, *Musca domestica*, which is also one of the book-destroying insects. There are a number of instances where the maggots of the fly have been found living upon paper, kept in damp places, but the damage done directly to the book is as nothing when compared to the damage done by their transferring germs, and, unless means are taken for their extermination, they will rank first among book enemies, because those who know of the fly's ability to carry disease germs, will refuse to read any book which the fly has stained. The common house-fly is only found around the habitation of man, showing that it has evolved from some other form which formerly lived in the open until it has now become thoroughly domesticated, as other forms have done, are doing, and will do in the future.

According to Dr. Howard, a single female fly in the spring might, therefore, become the progenitor of 195,-312,500,000,000,000 flies by the end of the summer or mid-autumn, and allowing one million flies to a bushel makes over 193 million bushels, each one of whom is capable of spreading contagion. An investigation made at the Agricultural Experiment Station at Storrs, Connecticut, in 1908, upon 414 flies, showed that the number of bacteria on a single fly may range all the way from 550 to 6,600,000, an average of one and one-fourth millions bacteria on each, an almost incredible number to be found on such a small object. The objectionable class, coli-aerogenes type, was two and one-half times as abundant as the favorable acid type. Now this only includes those on the outside, and every bacteriologist knows that large numbers are found in the intestines and expelled with the excreta. Mr. N. A. Cobb, in his article "The House-Fly,"[3] states that a well-fed fly defecates 104 times in less than two hours, and that spores were found in fifty-five of the specks. These specks, containing germs, are laid upon the covers or pages of the books, and as personal observation shows that a very large portion of readers moisten their fingers in turning over the leaves of a book, it is readily seen how the fly speck upon the paper is moistened, adheres to the finger and the germs transplanted to the mouth, where they at once find the proper conditions and proceed to breed, resulting in the reader becoming afflicted with the disease, the source of which it is impossible to trace, on account of the slight consideration given by the medical world at the present time to books as a source of disease.

The danger of contracting disease by the fingers dampened with saliva in order to turn over the pages of a book is especially so in the case of persons suffering from tuberculosis, whose sputum contains millions of the bacilli. The saliva drying, the *Tubercle bacilli* cling to the fiber of the paper, and as soon as another person, who also has the vulgar habit of wetting the fingers in turning the pages, uses the book, the germs are removed to fertile soil. Many other diseases, especially skin diseases, are without doubt frequently transmitted by this means.

In conclusion, I cannot speak strongly enough on the importance of cleanliness in preventing the destruction of books by insects, and the spreading of disease. The volumes in the library should be kept thoroughly cleaned, the attendants ought to clean their hands frequently, and the patrons compelled to wash their hands before using the publications and should not be allowed to wet the fingers in turning pages. These precautions will help to decrease the spread of tuberculosis and other diseases, and do away with the grease stains on the paper, which are breeding grounds for germs and attractive feeding places for insects. Screens should be placed on all windows and doors to prevent the entrance of flies, and by these means only will the destruction of the stores of accumulated knowledge be decreased and a source of death be overcome.

[3] *National Geographic Magazine*, vol. xxi., 1910, pp. 371–380.

Human Evidence of Evolution*

Is Natural Selection Dependent on Small Variations or on Large Mutations?

By A. M. Gossage, M.D.

The problems of heredity are attracting a gratifying amount of attention from many classes—the general public, the professed biologist, the mathematician, and, of late, the medical profession. Naturally it is the inheritance of human qualities which excites the greatest interest; and there is always a desire to extend to the human race any conclusions founded on the study of animals or plants. It has been claimed by Archdall Reid that the study of human beings is as advanced, or even more advanced, than that of animals, and in itself affords sufficient evidence to decide many controversial points. In this article it is proposed to examine some of the more important evidence that can be culled from the study of human heredity, and to see what conclusions may be justified.

There are certain obvious disadvantages in the human species, as compared with animals and plants, for the investigation of the problems of heredity. To begin with, the families are small: the offspring appearing one at a time, with intervals of many months between succeeding infants. Then the period of growth is prolonged, lasting twenty to twenty-five years, and, in consequence, it is excessively rare to have more than three generations alive at the same time and available for observation. The conditions, therefore, of preceding generations can only be ascertained from the accounts, often inaccurate, of the older members of the family. It is also impossible to arrange human parentage, and the inquirer is dependent on chance marriages for the production of a particular cross which may be required to throw light on some obscure point. These objections must not, however, be taken to imply that carefully collected observations, subjected to strict criticism, may not supply very valuable facts; but at present the number of properly verified facts is not great and there is urgent need for more.

In his book on the "Laws of Heredity," Dr. Archdall Reid comes to the general conclusion that evolution takes place by the action of Natural Selection on the small differences between parents and children, insuring the continuance of the more favorable variations. It follows as a corollary of this that an unfavorable variation, or one that does not tend toward the adaptation of the individual to his environment, tends to be gradually eliminated. A logical deduction from this theory is, that in human beings bacterial diseases should eliminate those most suspectible to them, and that, since the more immune have the best chance of survival, and so of propagation, the immunity of a community exposed to a severe bacterial disease should gradually increase. This is a logical deduction from the theory, and, if the facts accord with it, strong favorable evidence would be afforded; but if, on the other hand, the facts are not in accord, a very cogent argument would be raised against the original theory. Since this theory of evolution by the action of Natural Selection on small continuous variations is by no means universally accepted it becomes important to ascertain accurately what are the facts with regard to the susceptibility and immunity of human beings toward the various bacterial infections. That persons differ in their susceptibility to infection seems sufficiently clear, but the knowledge of how far these degrees of susceptibility are transmitted from parents to children is decidedly hazy. Still there is definite evidence that susceptibility or immunity to rust is inherited in wheat, and in spite of the strong opposition of some authorities it is generally accepted that susceptibility to tuberculosis runs in families. Beyond these points the recorded observations are not either sufficiently numerous or accurate to warrant any really definite conclusions, though, on the whole, they seem to the writer to weigh against the theory. Measles and malaria may be taken as types of bacterial disease for consideration. Measles is a disorder which attacks nearly all European children, and after an attack the acquired immunity is very complete. The disease is, as a rule, mild in type, even in childhood, and the death rate is not high. There are, however, some countries where measles is not endemic, and where the adult inhabitants are not protected by a previous attack. In these places there has been no elimination of the susceptible in past generations, so that on the introduction of the contagium there is a virgin soil for it to work on. With the gradual spread of Europeans over the world in the last century opportunities for infection have arisen, and the results have been severe epidemics. In these, adults and children have both suffered, the case mortality has been very high, and the illness has always been much more grave than in Europe. For instance, the population of the Fiji Islands was nearly decimated by measles on its first introduction there. As far as this goes it is in favor of Archdall Reid's conclusions, but it is possible to advance another hypothesis to explain the facts, and at present we have no means of dealing between the opposing explanations. One may suppose that the higher immunity of the European child is due to the transmission to it through the placenta, from the mother, of some of the immunity acquired by her during an attack in childhood. A similar transfer of immunity through the placenta is known to take place when a woman is vaccinated during pregnancy, her child being immune to vaccination for many months after birth.

Malaria is now mainly a disease of tropical and subtropical countries, and is due to infection with a special organism which is conveyed from the sick to the healthy by means of a particular kind of mosquito. As a matter of fact more than one disease is included under the term "malaria," each kind being due to a separate organism. They all occur, however, in similar places and may be considered together, since at present the knowledge concerning them is insufficient to enable us to discuss them separately. One must recognize that they differ in severity, some, e. g., the æstivo-autumnal, being much more severe than the others, and individuals may differ both in acquired and inborn immunity to the different kinds. Extended observations have conclusively shown that the adult native of India or West Africa suffers much less severely from these diseases than do such Europeans as go out to malarial districts, and it is tempting to conclude from this that the white race is naturally more susceptible to infection, and shows less resistance after infection, than the black. But it is also possible that the individual black adult may have acquired insusceptibility by reason of previous attacks or residence in the district, and that at birth there is no difference between the two races. This latter hypothesis is supported by the fact that white settlers, who do not die, get "salted" by prolonged residence in malarial climates, and that the black children suffer very severely and many of them die. If the explanation is correct, then white children born in India or Africa should suffer no more than the natives; and where the two races have been for several generations in the same locality, they should be affected equally, or rather, the white should be attacked less than

* Reprinted from *Bedrock*.

the black, because they are less exposed to infection. This point requires further careful investigation, but Leonard Rogers, in his book on "Tropical Fevers," tells us that in a particular district in India the Hindu children were found to be more severely affected than the English; and Deaderick, in his book on "Malaria," says that in the Southern States of America the black population suffers more severely than the white. Thus, as far as it goes, the evidence is against the view that there is evolution of immunity against malaria, and since, theoretically, this ought to occur, the evidence weighs for what it is worth against the view that Evolution takes place by the action of Natural Selection on small continuous variations.

The opposing view that Evolution is dependent on the action of Natural Selection on large variations or mutations, is intimately bound up with the Mendelian hypothesis. The phenomena of human inheritance have been cited both for and against these hypotheses. For the reasons already given the facts are not sufficiently definite to afford any conclusive argument on either side. What one is justified in concluding concerning human beings is that, if mutations can be proved to occur and persist in animals and plants, then they also occur in human beings; and, further, that if the Mendelian hypothesis is the correct explanation of the facts derived from experimental breeding of plants and animals, then it is also the correct explanation of numerous examples of heredity in man. Some critics of Mendelism complain that its advocates merely add other quite similar phenomena to the collection already obtained instead of breaking into fresh fields. These same critics, almost in the same breath, while acknowledging the accuracy of most of the recorded observations, claim that this Mendelian, or alternative, type of inheritance is exceptional. The multiplication of examples becomes, therefore, necessary to confute this argument, apart from the interest of the observations themselves and the fact that they frequently open up fresh problems. In this connection it may be pointed out that there are over thirty recorded abnormalities in human beings where the condition is handed down to the descendants in a manner which agrees fairly closely with what would be expected from Mendel's laws. The same may be said of some normal conditions, such as eye-color, or red hair.

The study of these abnormalities brings out a number of interesting points and justifies some important conclusions. The majority of them do not shorten life, and many interfere only slightly with the individual's capacity for earning a livelihood. In no case, however, can they be regarded as an advantage or an adaptation to the environment, and in some they prove a very distinct disability. For instance, the claw-hand and foot deformity must hamper the unfortunate possessors in the struggle for existence; and sufferers from multiple telangiectasis or angioneurotic œdema tend to die, because of their peculiarity, at an abnormally early age. Yet these conditions persist, being handed down to posterity in a certain definite proportion, and no tendency is shown for them to die out. Perhaps the most remarkable examples of this persistence of a disability through many generations of a family are afforded by the conditions known as Hæmophilia and Pseudo-hypertrophic Paralysis. The first of these causes the death of a very large proportion of the sufferers in early childhood from uncontrollable bleeding, while the second gradually cripples its unhappy victims, and nearly always renders them helpless and incapable of procreation by the time they reach adult life. In both of these conditions the affection is confined almost entirely to the male sex, and, were it handed down directly from father to son, would quickly die out. As a rule, however, it is through the female, who is herself unaffected, that the transmission takes place, some of the sisters of affected men passing the condition to some of their sons. A woman who carries this latent abnormality may not only give it to her sons, but may hand it down through her apparently normal daughter to her grandsons, or through her granddaughter to her great-grandsons, and so on. Thus the original connection with an affected family may be lost sight of where the males in each generation have been scarce. A hæmophilic male may transmit the condition to his grandson through his unaffected daughter, but, curiously enough, seldom transmits directly to his son. The children of the normal males of these families are always normal. As one can hardly imagine this curious peculiarity as having arisen by the action of Natural Selection on small fluctuating differences, one would be tempted at first glance to suppose that here was some special device to insure the continuance of these noxious plagues of humanity, a supposition which is supported by the fact that the females from hæmophilic families have a much larger number of children than is usual. On taking a wider view, however, one finds that an exactly similar type of inheritance prevails in Daltonism, or color-blindness, a condition in which there is no injury either to the individual's health or his prospects of earning a living and begetting children.

It is claimed by Dr. Archdall Reid, that the facts on which the Mendelian hypothesis is founded can be as well explained on the supposition that reproduction is alternative in these cases as that inheritance is alternative. I do not quite understand what is meant by alternative reproduction, but the supposition seems to imply that on crossing a "dominant" with a "recessive" there is temporary patency of the dominant character in the first generation and temporary latency of the recessive, while in succeeding generations there is more perfect and permanent patency of the dominant character in the "pure dominant" and of the recessive character in the "pure recessives," while in each the opposing character becomes permanently latent. In other words, the dominant character is considered to be always latent in the pure recessive and the recessive character in the pure dominant. This supposition affords no explanation of why a particular character is sometimes patent and sometimes latent, patency and latency seeming to be purely haphazard. It assumes the presence of the other *allelomorph* in pure dominants and pure recessives, although the only evidence of this is the rare occurrence of certain exceptions to Mendel's laws, exceptions which time may clear up. It also makes no attempt to offer a reason for the remarkable and constant numerical relationship of three apparent dominants to one recessive in the offspring of two cross-bred individuals. A hypothesis which gives no explanation of the most salient facts is quite useless. On the other hand, the Mendelian hypothesis of gametic purity does explain the facts and further enables a prediction to be made as to the result of the mating of certain individuals founded on their ancestry; for instance, it is possible to predict that all the male children of a color-blind woman will be color-blind. As the explanation of these particular facts, therefore, the Mendelian hypothesis is without rival. Still it is not enough to demonstrate that no other hypothesis will explain a particular group of facts in order to establish the truth of any hypothesis, but it is necessary that all the facts should be in agreement with the explanation offered. There are, of course, apparent exceptions to the Mendelian hypothesis, exceptions which may later be found explicable on that hypothesis, or, on the other hand, may render its acceptance impossible; but that does not take away the necessity for any rival hypothesis to offer a feasible explanation of all the facts before acceptance. These points are illustrated in human beings as well as in animals and plants, but, naturally, not so convincingly. There is plenty of evidence of the purity of recessives, and it is also found that, as would be expected, dominants of the rarer abnormalities, since they result from the union of an abnormal with a normal are always in a Mendelian sense, impure, so that half their children with a normal mate are abnormal and half normal, this relationship holding in most of these families where the numbers are sufficiently large. Difficulties and exceptions are naturally met with. For instance, dominance is, as in the case of the extra toes in fowls, sometimes incomplete, so that the abnormal condition is handed down through an apparently normal person, as occurs occasionally in Diabetes Insipidus, or Epidermolysis Bullosa. Then, again, the numbers sometimes do not correspond with expectancy.

It is of importance to note that the most striking example of blended inheritance, in spite of marked differences between the parents, is met with in human beings. It is generally acknowledged that the small continuous variations blend in the offspring while the large discontinuous variations, or mutations, do not blend and afford the examples of Mendelian "segregation." One would therefore expect that when there is interbreeding between two markedly dissimilar races, such as the European and the negro, that segregation would be found in the third generation with the production of a pure European and a pure negro. According to all the available accounts, however, not only are the children of a negro and a European a blend of the two races, but all the offspring of two half-breeds are also a blend, and there is a tendency to approach the white type when there is a further cross with a European, or the black when a person of mixed parentage mates with a negro. Genuine segregation seems to be confined to the imaginations of the novelists, who go so far as to suppose that there may be a reversion to a pure black type in the child of a pure European with a mate whose black strain is so slight that it could not be recognized on inspection (see "Senator North," by Mrs. Atherton). On the other hand, it has been stated that segregation is shown in crosses between white men and Red Indians; and recently Salaman has brought forward evidence which renders it probable that the characteristic Jewish features are recessive to the Gentile. Accurate and extended observations are much required on this question of racial admixture, and the United States of America should provide a fruitful field for such investigations, since, in addition to those already considered, some crosses between negroes and Red Indians and between negroes and Chinese and others should be found. In the first generation the children of negro and Chinese parents are said to resemble the Chinese except for woolly hair. The problem is a complex one, as there are probably several characters in which the two races differ; and while one character of one race may be dominant the others may be recessive, and the most interesting points should come out in the case of the progeny of two half-breeds.

In conclusion, attention may be drawn to the absence of any evidence of evolutionary change, either physical or mental, in the human animal during historic times. Modern man is anatomically superior to prehistoric man, but is no better equipped either with brain or muscle than the ancient Greek or Egyptian, any superiority he possesses being referable to the fact that he is able to profit easily by the hard-won acquirements of his ancestors, and, having acquired these, to pass on to fresh conquests. This emphasizes one of the mutationist's objections to the Darwinian theory of Evolution by the action of Natural Selection on small continuous variations, that it requires an infinitely longer period for the origin of species than geology is prepared to allow as the existence of a habitable Earth.

Coloring and Frosting Incandescent Lamps

By A. S. Neumark.

The following lamp colors are especially adapted for stage lighting and interior decorations; if applied properly they will outlast the lamps. A clear lacquer is first made by dissolving 32 pounds of gum copal in 20 gallons of alcohol (denatured) to which has been added 4 gallons of amyl alcohol (fusel-oil). It takes quite some time for the gum to dissolve completely, and the process should be assisted by shaking. Allow to settle, then draw off or decant; strain through several layers of cloth. It is not necessary that the liquid be completely clear. In the liquid so obtained dissolve the aniline dyes as given below. To every gallon of clear lacquer:

Red.—Rhodamine B extra 2 ounces; chrysoidine E cryst. 2 ounces; methyl violet ⅛ ounce.

Blue.—Blue Sp. t. 2 ounces; Victoria Blue 1 ounce.

Green.—Victoria green E 2 ounces; Methanyl yellow O 7/8 ounce.

Yellow.—Methanyl yellow 1 ounce; Chrysoidine E cryst. ½ ounce.

Straw.—Chrysoidine E cryst. ½ ounce.

Amber.—Chrysoidine E cryst. 1 ounce.

Orange.—Chrysoidine E cryst. 2 ounces.

Pink.—Rhodamine B extra 1½ ounces.

Purple.—Methyl violet 1½ ounces.

Moonlight.—Blue S. B. 1½ ounces; Methanyl 3/8 ounces.

Light Blue.—Blue S. B. 1½ ounces.

Blue-green.—Victoria green E 2 ounces.

Not all coal-tar dyes are suitable for coloring lamps. I have found that Blue S. B. (which is usually used) soon turns green and fades quickly; but the combination of the two dyes indicated will be lasting. There is also no single red dye, which furnishes a satisfactory dark red effect. The combination of amber, pink and purple, however, results in the desired shade.

The solution is filled into a suitable cup and the *hot* globes, which previously have been thoroughly cleaned, are dipped into this solution. Care must be taken that the solution is free from air bubbles and that the globes do not touch the sides of the cup. Amber and yellow can be applied to the cold lamps. One dipping is sufficient in most cases, provided the globes have been cleaned carefully.

FROSTING LAMPS.

Mix 1 gallon of acetone with 3 quarts of benzol and 1 quart of turpentine. Dissolve 24 ounces gum sandarac, 8 ounces gum benzoine and 8 ounces gum mastic. Shake well, let stand over night and strain through cheesecloth. The liquid will be perfectly clear, provided the bottles used have been perfectly dried; they should be rinsed out with alcohol before using. This solution is applied to the globes by dipping. The lamps must be *cold* and they should not be used before they are perfectly dry.

Both colorine and frosting liquid should be kept in glass bottles or stoneware jugs, but *never* in tin cans.

Frosting may be tinted with rhodamine, methanyl yellow and other dyes, although some of these dyes such as chrysoidine are nearly insoluble. The colors and the frosting can easily be removed from the globes by washing with a solution of caustic soda or alcohol.

The Kinematograph as an Aid to Mathematical Instruction

We read in *Prometheus* that L. Münch, of Darmstadt, has recently employed the kinematograph for demonstrating certain properties of geometrical figures. Thus, for instance, the transition from the circle to the ellipse by the gradual spreading out of the foci from the center can be very nicely demonstrated in a way which appeals to the imagination, as yet untrained, of the novice.

The Library and Museum, With South Hall in Background on the Right.

View Looking East Toward Central Group of Buildings.

How Irrigation Founded a Scientific University

A Center for Technical Education in Arizona

By Day Allen Willey

IRRIGATION in the arid regions of the southwest, has accomplished far more than nourishing the dry soil and making it fertile for crops. It has created home-sites for farmers, villages and cities. In one of these cities whose site is on what was formerly a desert, is an educational center. Its campus now beautifully adorned by Nature, thirty years ago was covered by sage brush and cactus, and not a human being could live upon it. So it may be said that the University of Arizona owes its existence to the coming of the water, bringing civilization. Without irrigation it never would have been built and opened for instruction.

While such branches as agriculture and a general college course are included in the courses of instruction, the school is essentially a source of scientific education, fitting students for the professions of civil engineering, electrical, mechanical and mining engineering, as well as metallurgy and the mechanical arts. Associated with the university is a preparatory school in which boys and girls are instructed to a standard where they take up the courses in the university proper. While the student body is not as numerous as at Cornell, Sheffield or the larger eastern technical centers, in its equipment and instruction this educational center covers a very broad field. The high standard of its graduates as engineers and mining experts shows the proficiency and thoroughness of the plan for instruction.

Opened ten years ago, the University of Arizona was organized under the law giving colleges of this class land grants. Its faculty aims to elevate it to the same important position in the southwest that the universities in such States as California and Wisconsin have attained, but as stated, it is already a broad source of engineering education and no similar institution in the country has more modern and varied apparatus and other equipment for this purpose. What it means to the State from the industrial development point of view is indicated by the wording of its charter. It is "to provide the inhabitants of this Territory with the means of acquiring a thorough knowledge of the various branches of literature, science, and the arts," and so far as possible, a technical education adapted to the development of the peculiar resources of Arizona.

In furtherance of this latter purpose, instruction is provided especially in subjects fundamental to agriculture, the mechanic arts, mining and metallurgy. The university, by the nature of its situation, frankly lays special emphasis upon the course in mining engineering. It is, in reality, a mining laboratory, surrounded as it is on all sides by mines. Some of these mines, developed on a large scale, are within a few miles of the city, and the number and magnitude of such enterprises are steadily increasing. Probably no university in the United States offers such advantages to the students of mining engineering, who desire to see the actual operation of great mines or the development of such enterprises, while carrying on the theoretical and experimental work of the mining course.

The advantages in civil engineering are also noteworthy, for Tucson, where the university is located, is not only a division point on the main line of the Southern Pacific Railroad, with large shops, roundhouses, and engineering offices, but it has the administrative and engineering headquarters for five of the subsidiary or allied lines of the Pacific system in Arizona and in Sonora, Mexico, commonly known as the Randolph Lines, including the great West Coast Line which will reach from Guaymas to Mazarlan and Guadalajara, in Mexico. All of these lines are undergoing extensive expansion and rebuilding, and so furnish excellent opportunities for observation and vacation employment for students of civil engineering.

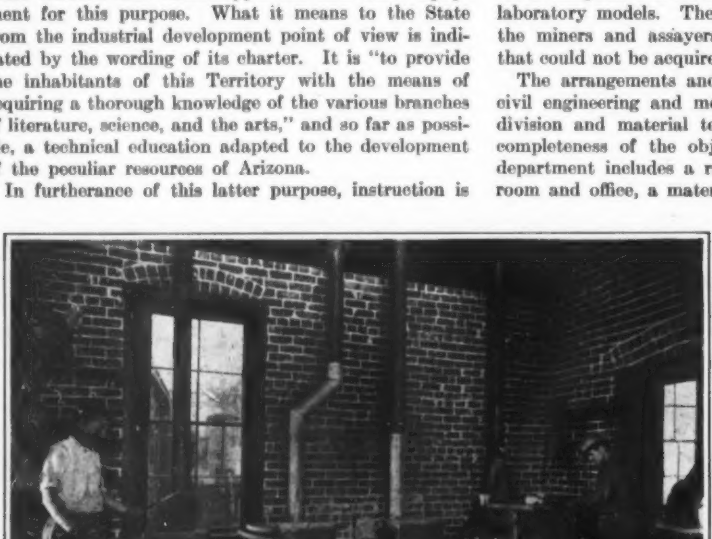
The mines in the vicinity of the university, in most cases, have the latest type of machinery for securing the ores, and treating them by the most economical and metal saving methods. With the opportunity to enter the mines and study the mechanism and operation of the plants, the advanced students obtain a far more complete and accurate knowledge than with the laboratory models. They are permitted to work with the miners and assayers and thus get an experience that could not be acquired in any other institution.

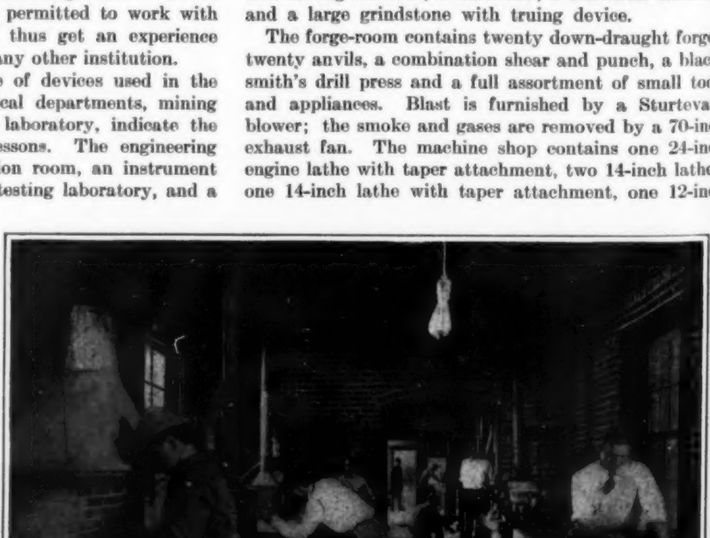
The arrangements and type of devices used in the civil engineering and mechanical departments, mining division and material testing laboratory, indicate the completeness of the object lessons. The engineering department includes a recitation room, an instrument room and office, a materials' testing laboratory, and a drafting room. The other rooms are in the shop and assay building. The instrument room contains lockers in which the surveying instruments are kept. These include six transits, three levels, two plane tables, two compasses, a sextant, a considerable number of small instruments and other equipment required for field work.

The materials' testing laboratory is fitted for making physical tests of wood, iron, steel, stone, cement, concrete, and other materials used in engineering construction. The apparatus includes an Olsen 100,000-pound universal testing machine, a duplex micrometer extensometer, a Fairbanks cement testing machine, briquette molds, club molds, molds for concrete beams, molds for specimens for testing shearing strength of concrete, a Vicat needle machine, specific gravity flasks, sieves, a moist chamber and other auxiliary equipment, in addition to drawing chuck and change-gears. Other appliances for study include the latest models of shapers, planers, and a large universal milling machine, also grinders, drills, hack saws, hoists, all operated by electric power served by individual motors.

As in the wood working department, all the apparatus is of such dimensions and capacity as in actual mill and factory practice. The same is true of the mechanical and electrical laboratory. This includes the shops and drawing rooms of the mechanical section which occupy a total floor area of about 8,000 square feet, divided into a large shop and machinery room, with adjacent tool, supply and store rooms; draughting, model, pattern, lecture rooms and office. The wood shop is equipped with a full assortment of hand tools, twenty-four benches with a complete set of tools with each, six turning lathes, Beach scroll saw, a Whitney dimension sawing machine, a band saw, a Universal trimmer, and a large grindstone with truing device.

The forge-room contains twenty down-draught forges, twenty anvils, a combination shear and punch, a blacksmith's drill press and a full assortment of small tools and appliances. Blast is furnished by a Sturtevant blower; the smoke and gases are removed by a 70-inch exhaust fan. The machine shop contains one 24-inch engine lathe with taper attachment, two 14-inch lathes, one 14-inch lathe with taper attachment, one 12-inch





Scenes From the Metallurgical Laboratory in the Shop Building.

View in the Museum.

Portion of the Physics Laboratory.

lathe with taper attachment, drawing chuck, and English and Metric change gears; one 10-inch speed lathe, one 16-inch shaper, one 24-inch by 6-foot Powel planer, one Universal milling machine, one Universal grinder, one 24-inch drill press, 13-inch sensitive drill, power hack saw, drill grinder, emery stand, grinding attachment for lathes, 1½-ton portable hoist, 1-ton triple hoist, ½-ton screw hoist.

Each shop has its own tool room well equipped with small tools, gages, measuring instruments, etc. A large collection of working drawings, and sample collections of models, machine parts, valves, electrical fittings, insulating materials, abrasives, etc. The laboratory is equipped for experimental work in the study and operation of steam boilers, steam and gas engines, hydraulic and electrical machinery.

Besides the machinery of the shop and mill which can be used for the study of machine design as well as for experimental work, the university has a 45 horse-power return tubular boiler, a 35 horse-power center crank engine, a 60 horse-power high speed automatic side crank engine, to be direct connected to a generator, a 30 horse-power engine, a 10 by 7 by 10 duplex direct-acting steam pump, a small duplex pump, a 40 horse-power Fairbanks Morse gasoline engine direct connected to a 500-gallon high pressure fire pump, a 23-kilowatt direct-current generator, a 5-kilowatt rotary converter, a 7 horse-power induction motor, a 3 horse-power and a ½ horse-power direct-current motor.

An 8-inch by 10-inch triplex pump with its electric motor, serves as part of the equipment of the mechanical electrical laboratory, and also furnishes the university with its water supply. The department is well equipped with electrical measuring instruments, steam indicators, gages, weighing scales, etc. For the testing of pumping machinery, a large steel weir box, overflowing into a cement cistern, is connected by suitable piping to the various pumps in the laboratory. The dimensions and power of this equipment, give the student an opportunity to study designs that are actually operated in industry.

While, as already stated, the advanced students have opportunities to visit mines and there study the ore formation, mining, the use of electrical drills and other devices of late design, the metallurgical laboratory where they secure their first education, is notable for its mechanism for instruction by operation as well as by study.

The apparatus for liquid treatment of ore for separation includes two ore crushers, 4 inches by 7 inches, and 4 inches by 6 inches; sampling rolls, 6 inches by 9 inches, a cone and burr sample grinder; a pebble mill with a capacity of about 15 pounds at one charge; a laboratory lightning crusher and a disk pulverizer; a 5-stamp mill, with 800-pound stamps; a 3-stamp mill, with 250-pound stamps; inside and outside amalgamated plates for the same; a 2-foot clean-up pan; a 1-foot amalgamation pan, and a 9-jar revolving agitator for testing samples of a few ounces, a table of the latest pattern, and a hand jig; a 1½-ton cyanide plant for treating sands or dry crushed ore; two 150-pound cyanide plants for treating smaller samples; a 3-foot agitator; a 12-inch, 6-chamber flush plate and frame, washing filter press and pump for the same; shaking screens; ore feeder; belt and bucket elevator, sampling plates, split samplers, percolators, sizing screens from 1-mesh to 200-mesh, miners' pans, and retorts. The power for operating this plant is furnished by a 30 horse-power Westinghouse induction motor.

The ores treated are galena and silicious gangue in lead. Copper ores include chalcopyrite, pyrite with galena and silicious gangue. The tungsten ores include wolframite and quartz gangue, while the free milling ores are gold and silver. Consequently, the students of metallurgy have an opportunity to analyze a great variety of ore bearing material.

The crushing for a gold mill illustrates the thoroughness of the process carried out. The equipment of the mill includes five 1,800-pound stamps. The ore is crushed by a 4 by 7-inch crusher, to inch sizes, then carried by an electrically operated conveyer to the stamp battery. It is fed automatically by a feeder. The battery has a capacity of 20 tons in 24 hours. In crushing for sampling or for runs of small quantities of ore by the miniature plants, the ore passes through a 4 by 6-inch crusher, then through 6 by 9-inch rolls, and finally the sample grinder. The capacity equals any demand. Fifty to hundred-pound lots are ordinarily treated.

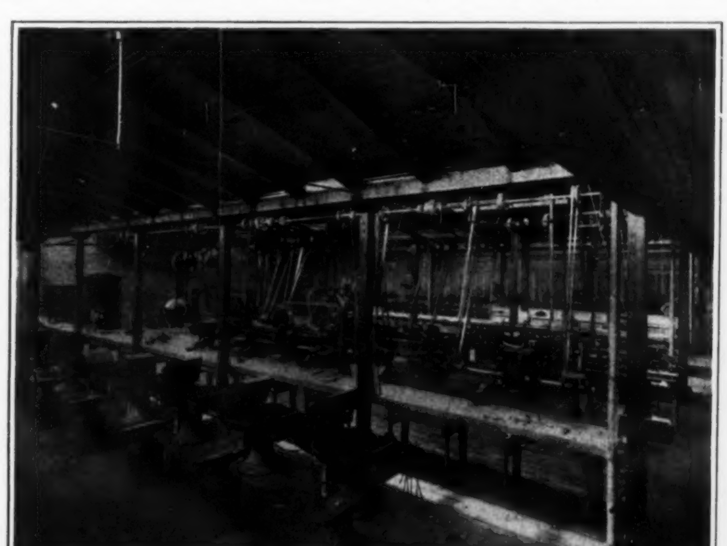
Another section is the location of what is known as the Callow miniature plant, consisting of one small two-compartment Harz jig, one small Wilfley table, one amalgamating plate, one set hydraulic classifiers, one set cyanide agitators, one automatic feeder. This plant is driven by a 1/8 horse-power motor and stands on a hopper bottom tank divided into three compartments. It is a complete ore-dressing plant and cyanide mill, and tests quantities of ore ranging in amounts from 25 to 400 pounds. While it is merely a model, it is a complete and accurate imitation of such a plant for industrial operation.

The class in ore dressing makes complete concentration tests by the Callow miniature plant. The ores treated are copper and tungsten. The work is an illustration of stage crushing and stage concentration, the usual method with sulphide ores. It is the kind of a test that is often made for mining companies, who send ore to the university to be tested for process, because of the skill of the ore-testing department in making tests, and the mechanical facilities. The student works out the results on a flow sheet, to suit the particular ore, and finally reports the saving that he has made in the test. The flow sheet that the student has worked out as being the most desirable should be the proper routine for a large plant treating this ore. Thus the mining companies make use of the university system in determining the best methods to employ.

The class in gold and silver treat these ores. The gold ore plate amalgamation run and the tails are cyanided by the "all slime" process, thus a high extraction is secured (98 per cent). The silver ore test run is a very interesting process. The student determines the acidity of the ore to enable him to add the correct amount of alkali to neutralize acidity, then he makes some preliminary agitation tests on fine ground ore, using stirrers of the Callow miniature plant. Next he makes some percolation tests by glass percolators. Extraction and consumption of cyanide are thus determined. The student then crushes coarse material (20-mesh) and treats it.

One of the requirements of the university curriculum is a senior trip to the mines, with the instructor in the mining department. The mining underground lasts a period of six weeks, but most of the men put in at least two summers' work, and many have spent the summer

In the Chemical Laboratory.



The Blacksmith's and Machine Shop.

for several years at mining. This gives the students a knowledge of mining not obtained by the average eastern student, as it gives him a practical education by actual employment in the mines. Such is the interest in mineralogy and metallurgy that the majority of students, no matter what branch of engineering they take up in school, go into mining sooner or later. A smaller number find work with railroads, but some of these later take up mining. Any graduate who desires to get employment in a mine finds a place with some company and generally secures a good position because his instruction has been thorough.

The opportunities for getting object lessons in mining education are shown by the fact that nearly a fourth of the copper of the United States is mined within one hundred miles of the university. The directors of the greatest copper company are so interested in the work of the university that they presented it with a gymnasium, and one member of the company has given a fund for purchase of scientific instruments for research work. The co-operation of the mining companies with the institution is invaluable in its influence upon the scientific instruction. The laboratory for microscopic work is equipped with seven petrographic microscopes, including both American and foreign make; one Zeiss binocular for opaque work, also models for illustrating axes of elasticity and spherical projection.

The study of electricity, aside from its use in engineering work, is considered of much importance in the university curriculum. Here, again, is noticed the very complete display of electrical devices. A lecture room, seating forty persons, is fitted with every modern convenience, such as lights, water, gas, heliostat, alternating and direct currents of great range, an opaque projection lantern, elevated seats, shutters for darkening the room, etc. Two large main laboratory rooms supply space for mechanical and electrical work, while separate special rooms are devoted to heat, sound, light, magnetism and research work.

A carpenter's shop, a repair and store room, a photographic dark and enlarging room, and a constant temperature room are provided. A pendulum seismograph will be installed in the magnetic laboratory and a special space has been provided for a 55-foot Foucault pendulum and the study of falling bodies. An 8-inch induction coil with storage and X-ray accessories is used in the study of high-tension electricity. This has recently been supplemented by a large Oudin resonator and a mercury interrupter, manufactured by Cox, and a Tesla high-frequency coil of the Elster and Geitel type.

Stereoscopic Vision

The Crossed and Direct Method of Viewing Objects

By Frederic Campbell, Sc.D., 2d Vice-President, Department of Astronomy, Brooklyn Institute

THE article by R. W. Carleton, in a recent number of the SCIENTIFIC AMERICAN, entitled "Stereoscopic Effects Without Apparatus," calls attention to a remarkable method of vision, with which he claims that it is "possible to obtain stereoscopic effects without the use of any stereoscopic apparatus." The experiment of looking

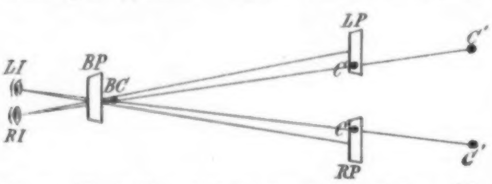


Fig. 1.—Illustrating straight stereoscopic vision. *LI*, left eye, *RI*, right eye; *LP*, left picture; *RP*, right picture; the lines of vision to these are nearly parallel, and the pictures blend into one in the far distance; *C*, comet in each picture, the two nearer than the centers of the pictures, requiring the eyes to become slightly crossed, as in viewing near objects, thus making the comet appear nearer than the backgr und; the dotted lines to the comet picture would meet far this side of the meeting-place of the unbroken lines. (Drawn by the Author.)

"cross-eyed" at two identical pictures, which he proposes, is a difficult one, and yet, in the experience of the present writer, not impracticable. For not only the two sides of a regular stereoscopic picture, but also two pictures of any kind that are exactly alike (unless they be very large), and even two similar objects, or four or eight, I have found can be treated in this way.

Standing in the gymnasium before two Indian clubs or dumbbells hanging on the wall, I have looked at the left with the right eye, and at the right with the left eye, the two clubs or dumbbells merging into a single one, standing near the eyes, at the point where the lines of vision cross. But, having done this with two clubs, I found it could be done with two pairs of clubs, and then with four pairs of clubs, pairs 3 and 4 merging with pairs 1 and 2, so that I found myself calmly and deliberately surveying a single pair of pairs, and these several feet nearer my eyes than the originals. The single clubs, not only, but the pairs, were necessarily evenly spaced, the distances between the centers of the pairs being between 2 and 3 feet.

The "rounded beauty" of which Mr. Carleton speaks, however, I do not discover as it usually appears in the straight stereoscopic vision, in which each eye looks straight ahead. Indeed, I question whether it is there, except in the imagination of the beholder. In ordinary stereoscopic vision the "rounded beauty" of the scene is obtained by making the two pictures slightly different in accordance with the theory of perspective. The objects intended to be seen nearer to the eyes are placed a little nearer to each other, making it necessary for the eyes to turn a little toward each other, "cross-eyed," which is the way they always do in looking at near objects. The pull of the eyes toward each other tells us that the object seen is nearer. Hence, when we give them an artificial pull and yet obtain a clear image, no matter what its origin, the mind is impressed with its apparent nearness.

Now, whether one use the straight stereoscopic vision or the "cross-eyed," if the two pictures blended into one are exactly alike, the eye sees them just as flat on the paper as in ordinary vision, and there is no "rounded beauty" whatever. You do not see any further around an apple, for example, shown in this way, if the two pictures of the apple are just alike. But if they be different, being taken from two different points of view, then, with the straight stereoscopic vision, one obtains perspective, depth, solidity, space, and the object "stands out" as we say, round and charming because of its revealed form, instead of flat and characterless.

But this I do not discover in the cross-eyed vision. It is true that the blended picture comes near you to the point where you hold up your pencil or finger and focus your vision. There it hangs, reduced in size because really at a distance and not enlarged as would be expected when brought so near, but beautiful because so sharp and clear and so etherial, hanging in mid-air. But it has not obtained perspective by this treatment. As for the perspective obtained by the straight stereoscopic vision of a stereoscope picture, in which the two counterparts are slightly different, it is a very interesting question whether that is obtained by viewing it in precisely the opposite way, that is, cross-eyed instead of straight.

Now, inasmuch as looking cross-eyed at the picture is reversing the usual way, the result will be the same as if the two halves of the stereoscopic picture were transposed. As originally printed, the nearer objects are slightly nearer each other than the centers, hence look nearer by making us look cross-eyed; but, when transposed, the hitherto nearer objects are now farther from each other than the centers, hence require us to look straighter than ever; and the straighter the look, that is, the more closely parallel the two lines of vision, the more distant is the object. So the perspective is entirely re-

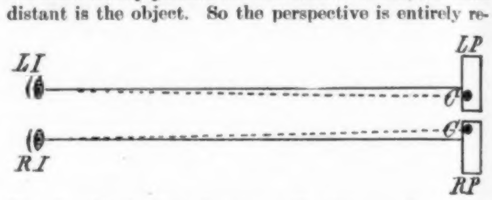


Fig. 2.—Illustrating "cross-eyed" stereoscopic vision. *LI*, left eye; *RI*, right eye; *LP*, left picture; *RP*, right picture; *C*, comet in each picture, the two nearer than the centers of the pictures, requiring the crossed eyes to look straighter and making the comet appear more distant, at *C'*; *BP*, blended picture, where the lines of vision cross; *BC*, blended comet, where the lines of vision to the comet cross, namely, at a point back of the blended picture. (Drawn by the Author.)

versed when the pictures are transposed, things originally in the foreground being now in the background. That this is the effect of the cross-eyed vision is more directly shown by Fig. 2, wherein the comet, C, is nearer the comet, C, in the other picture, than are the centers of those pictures; the lines of sight are thus more nearly parallel, as they would be for a more distant object; hence the comet, to the crossed eyes, appears at C', i.e., at the rear of the rest of the picture.

By crossing the eyes you have thus virtually transposed the two halves of the stereoscopic picture, so that what was far now appears near, and what was near now appears far. With an ordinary landscape view this is not readily perceived; for comparative sizes, lights and shades all enter into impressions of distance. But the proof of the above statements is found in certain simpler pictures taken as tests.

Mr. Carleton speaks, for example, of a stereographic view of Brooks' comet recently printed in the SCIENTIFIC AMERICAN as affording "great and awe-inspiring delight" when viewed in the cross-eyed way, "without the use of a stereoscope." The comet did not appear on the surface of the paper," he says, "but far away in the depths of star space." And that is just where he viewed it wrong. It should not have appeared "far away in the depths of star space," but nearer than the stars, which it really was; and thus it does appear, hanging between us and the stars, when viewed with the stereoscope, or viewed stereoscopically without the stereoscope; for this straight and distant vision, the true stereoscopic vision, is also possible and becomes easy with practice, as the writer knows from numerous experiments. The truth is, in accordance with what is said above, the cross-eyed vision puts the comet back of the stars, making the entire heavenly host nearer than the passing comet, which, while beautiful enough, is not according to fact. A stereoscopic picture of the wire cage (Fig. 3) proves the same thing; viewed straight, one sees into and through the cage very wonderfully; viewed cross-eyed, what was the front of the cage now becomes its back. In other words, the cage is turned inside out.

The cross-eyed vision must, therefore, while most interesting as a proof of optical possibilities, be relegated to the department of acrobatics; but the straight stereoscopic vision, alone entitles to the name, because it shows things as they are and in the perspective to which they are entitled, is destined to become more and more useful and entertaining in science and art.

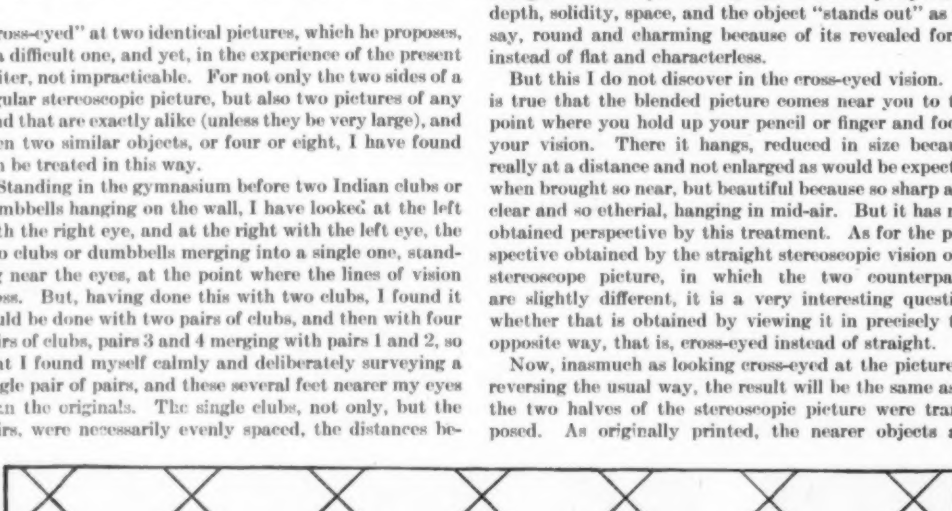


Fig. 3.—Wire cage, with stereoscopic effect. Note that the two are slightly different. Viewed stereoscopically, with or without instrument, it appears like a globe, hanging in mid-air, with the minute central circle nearest observer. Viewed with crossed eyes, all is reversed, the minute circle being farthest from observer. (By permision of Underwood & Underwood.)

The Mode of Propagation of Infantile Paralysis

The Bedbug as a Spreader of Disease

In an article published in a recent number of the *Medical Times*, Dr. Jacolyn Van Vliet Manning brings forward a theory as to the probable mode of propagation of infantile paralysis. This is, at the present time, as yet surrounded with considerable mystery, and in fact it is easier to quote negative evidence such as to exclude certain modes of propagation, than to point to positive evidence which would give a clue as to the actual mode. Dr. Manning draws attention to a number of peculiar facts relating to the disease. Thus poliomyelitis, as it is technically called, displays a peculiar caprice in the selection of its victims. All members of a family may have the disease, but more commonly one child suffers. This is generally seen to occur in all epidemics, and repeatedly in each.

"Cases of poliomyelitis in hospitals, schools and institutions have rarely been followed by the development of other cases, while local epidemics have apparently demonstrated direct transmission from case to case or by the healthy intermediate carrier.

"Satisfactory proof that susceptibility to poliomyelitis varies to any considerable extent is lacking. Although cases may vary greatly in severity, from the mildest case of the arrested type to the rapidly fatal 7 or 8-hour case, the personal reaction to the infection may be due to individual variation of eliminative function, or qualitative variation of the virus. No proof has been offered that any person is immune to this infection.

"The contagious nature of poliomyelitis was supported by Wickman, who traced channels of contact from case to case throughout many small communities in Sweden. This theory has been supported by a majority of investigators of epidemics, including the writer, who announced her belief that the epidemic was transmitted from Scandinavia to the Port of New York and thence to Wisconsin in 1908 (Manning, "Poliomyelitis in Wisconsin," *Wisconsin Medical Journal*, April, 1909), finding at that time no other credible explanation of the spread of the plague."

Dr. Manning further points out that the disease is probably not transmitted by ordinary contagion for the following reasons:

1. The experimental production of the disease in monkeys is by inoculation.
2. Experimental transmission has never been induced where there was no solution of continuity and where therefore a possible inoculation can be ruled out.
3. Poliomyelitis artificially induced in monkeys has never been spontaneously transmitted to animals confined in the same cage or room.
4. The comparative rarity of multiple cases in families.
5. Acute cases of poliomyelitis introduced in wards of hospitals not followed by a secondary case.
6. Fitful character of the extension of the epidemic in the United States, evidenced most plainly by the lapse of three years between its appearance in New York City and Washington, D. C., two great cities only a few hours apart.
7. Frequent epidemics of poliomyelitis in animals preceding and coincidental with human poliomyelitis may indicate that man is not the essential host of this disease.

It appears, then, that while the disease is beyond all question infectious, ordinary contagion, that is to say, transmission by mere contact or proximity of two persons does not occur. We must therefore look for some condition in which the disease germs have direct access to the tissues of the body and to the circulation, as in the case of inoculation. An obvious supposition, in the light of our present knowledge of other diseases, is that the disease is insect-carried, especially as it has been found by the Rockefeller Institute of Research that the virus of the disease is detectable in circulation in the blood of a monkey affected with the disease.

In this connection it is interesting briefly to review the history of our knowledge regarding insect-carried diseases. The earliest suggestion that the mosquito might be the carrier of malaria seems to have been made in 1807 by Crawford, an American physician. The matter was again referred to in 1848 by Nott, of New Orleans, and again in 1883 by King, of Washington, D. C. Laveran, who discovered the parasite of the disease in 1880, in 1891 declared his adherence to the mosquito theory. The German physician, Koch, is also said to have suggested the transmission of malaria through the agency of the mosquito. In 1894 Manson, of Dublin, appeared as a vigorous supporter of the mosquito theory as best calculated to explain the various conditions of the problem, and a little later Sir Ronald Ross took up the work with great energy, and to him is due the principal credit in finally establishing our full knowledge of the conditions in the transmission of malaria through the mosquito anopheles. It is now known that the mosquito is also responsible for the transmission of yellow fever, a theory first advanced by Dr. Carlos Finlay, of Havana, in 1891. It is also supposed that the mosquito has a part in the dissemination of leprosy and several other diseases. The transmission of diseases by the common house-fly has been discussed so much at length in various technical and popular journals, that its mere mention here will suffice. The rôle played by the rat and its flea in the propagation of the plague is also well known to every layman at the present time. A case is also on record of disease transmitted by ants, and roaches have been suspected of the same agency. The bedbug has been said to be responsible for the spread of leprosy, tuberculosis and other diseases. The great authority on the subject of insect-borne diseases, and especially malaria, is Sir Ronald Ross, whose name has already been mentioned, and who has of recent years also developed the mathematical discussion of the problems involved, his work in this direction having been published in his book, "Prevention of Malaria," second edition, Murray Company, and also in a brief abstract in a paper published in *Nature*, October 5th, 1911.

After this historical digression let us return to our main subject, namely, the transmission of infantile paralysis through some insect bite. Dr. Manning points out that in order to maintain that poliomyelitis could be transmitted by blood-sucking insects, it would be necessary to prove that:

a. "The virus of poliomyelitis permeated the bloodstream of the host during some portion of the attack, which, as mentioned above, is the case.

b. "Any insect to merit consideration as an obligatory factor in the transmission of poliomyelitis must be of almost world-wide distribution and perennial pervalence, for poliomyelitis has occurred in all latitudes from Australia to Canada, and while epidemics have been confined almost exclusively to the warm months, scattered cases have been reported in the United States in every month of the year. (Frost. "Field Investigation of Poliomyelitis," *Public Health Report* No. 55.)

"Of the blood-sucking insects which are commonly known in the United States, the mosquito, louse, bedbug, flea and tick, the mosquito, flea and tick are ruled out as they are distinctly annual and seasonal epidemics in the North Temperate Zone of North America, where epidemics of poliomyelitis have been most prevalent. The family of pediculi can also be ruled out as, unlike the mosquito and bedbug, they do not inject a blood-ferment while withdrawing blood of the host. They are also much less frequently encountered in ordinary American life than the other two pests, as personal cleanliness disbars their existence.

"The bedbug, *cimex lectularis*, is the blood-sucker who conforms to the requirements laid down by Dr. Frost, and to other requirements which an insect must fulfil to 'merit consideration as an obligatory factor in the transmission of poliomyelitis.'

"We will take up these requirements one at a time in a questionaire, and observe how closely cimex lectularis merits such consideration:

Cimex Lectularis.

Distribution? World wide.

Perennial? In artificially warmed domicile of any sort, and mild climates.

Seasonal increase in numbers? Multiplies enormously in summer months.

Increased in numbers by modern living? Steam and furnace heated tenements and lodging houses are choice breeding places for cimex.

Habitat? The domicile of man: beds, box-beds, folding beds, bedding; clothing; crevices about house; partitions of wood; chimneys.

May infest locality? Yes, tenements, hotels, stations, unholstered car seats and furniture, and generally insanitary homes, summer camps, and waterclosets.

Food? The blood of man; a blood-sucking parasite.

Preferred subject? The young child; the red-blooded healthy adult.

Transmitted by human carrier? With great frequency, especially in summer, due to increase in numbers and travel.

Easy transmission from bed of sickness? Any visitor whose clothing comes in contact with bedding may acquire one or more if present.

Comparatively even distribution among social strata? Present day methods of transportation might transmit cimex to any dressing room however exquisite, and all the well-to-do are not cleanly, while many of the poor are unavailably clean when juxtaposed with the unsanitary.

Children more frequently attacked than women? The democratic child frequently acquires cimex from an insanitary associate.

Men more frequently attacked than women? Men acquire cimex in many public places which women rarely frequent.

"The bedbug has long been tolerated, as the mosquito and septic fly were until recently, as a disgusting but harmless nuisance, yet he and his kind seem to have wakened suspicion as to their harmlessness many years ago, for Columella in the century before the Christian era, wrote of 'insects armed with stings, and pestilent . . . creeping things from which came obscure diseases.'

"Dr. Lovett in investigating 150 cases of poliomyelitis in the Massachusetts epidemic of 1909, found cimex lectularis present in 31 homes of the 142 families represented; that is to say 20 per cent of the 150 cases were known to have been exposed to attacks of cimex. Had these 142 families composed a small community, it is conceivable, each of the 150 cases might have been so bitten. (Lovett. "Poliomyelitis," in *Massachusetts Bulletin State Board*, June, 1910.)

"If the premise is granted that cimex may be the agency of transmission of poliomyelitis, we would expect to find the disease endemic in certain houses. Wickman noted such apparent endemicity, and reported it as proof of the contagious nature of poliomyelitis:

"The disease was not generally spread through the city (Stockholm), but was particularly localized in certain parts, so that in neighboring houses, groups of cases of three, five or seven, occurred. In one instance there occurred a case in one dwelling house from which the family moved on October 1st. A second case developed in this same house not long after the entrance of the family that moved into the rooms vacated by the first family." (Wickman.)

If cimex proves to be the usual agent in the transmission of poliomyelitis, there will be explained the reason for non-development of secondary cases of the disease in the well-ordered hospital or ward. The modern hospital, with fumigation and removal of patients' clothing, and frequent fumigation of wards and rooms does not harbor this pest. The unclean hospital ward, which harbored cimex might then be responsible for the rapidly fatal institutional disease form of poliomyelitis.

If cimex is the guilty agent of transmission, that would explain the fact that the epidemic of poliomyelitis in Nebraska was checked in mid-summer by the establishment of isolation, quarantine and post-fumigation.

"To summarize:

1. "The artificial propagation of poliomyelitis is by inoculation.
2. "The method of spontaneous production of poliomyelitis in man being unknown, we are warranted in the assumption that it takes place by inoculation.
3. "A blood-sucking insect is the agent of transmission by inoculation of several acute epidemic infectious diseases (e. g. malaria and yellow fever, the mosquito. Relapsing fever and kala-azar, the bedbug. Suspected: pellagra, the sand-fly.)
4. "Cimex lectularis, a blood-sucking insect, of world-wide distribution, perennial in habit, seasonal in increase, domiciled in the home, bedding and clothing of man, with the habit of migrating from sick to well, fulfills all requirements needed to explain the epidemiological peculiarities of poliomyelitis in man.

"Although the case gainst cimex is not yet proved, in view of the above would it not be well for the public to be informed of the strong probability that the bedbug is the agent in transmission of poliomyelitis, and to accomplish the wholesale destruction of this omnipresent parasite before the summer of 1912 opens?"

Fumigation by Iodine.

As is well known iodine is one of the most powerful antiseptics and has for some time past taken the leading place among the drugs used for this purpose by physicians. The most recent development in this direction is a process devised by Dr. Louge, of Marseilles, who has discovered a simple means of producing iodine fumes which are very readily applied to any part under treatment. Dr. Louge's process, as described in *La Nature*, consists in dipping a wad of cotton in iodoform powder, and then lighting it at a point which has been left free from iodoform powder. The burning tuft of cotton liberates violet vapors of iodine, which can either be directly applied to the part to be treated, or, being considerably heavier than air, may be allowed to collect in a beaker and may then be transferred, for instance by means of a syringe, to the structure under treatment.

In making use of the new process it must of course be remembered that iodine is very irritating to the eyes and the air passages. Care must therefore be taken to cover the patient's eyes and avoid breathing the vapor. The place where the process is carried out should be thoroughly well protected from draughts, as otherwise the iodine fumes spread throughout the room and become very objectionable. Nickeled objects are badly attacked by the vapor.

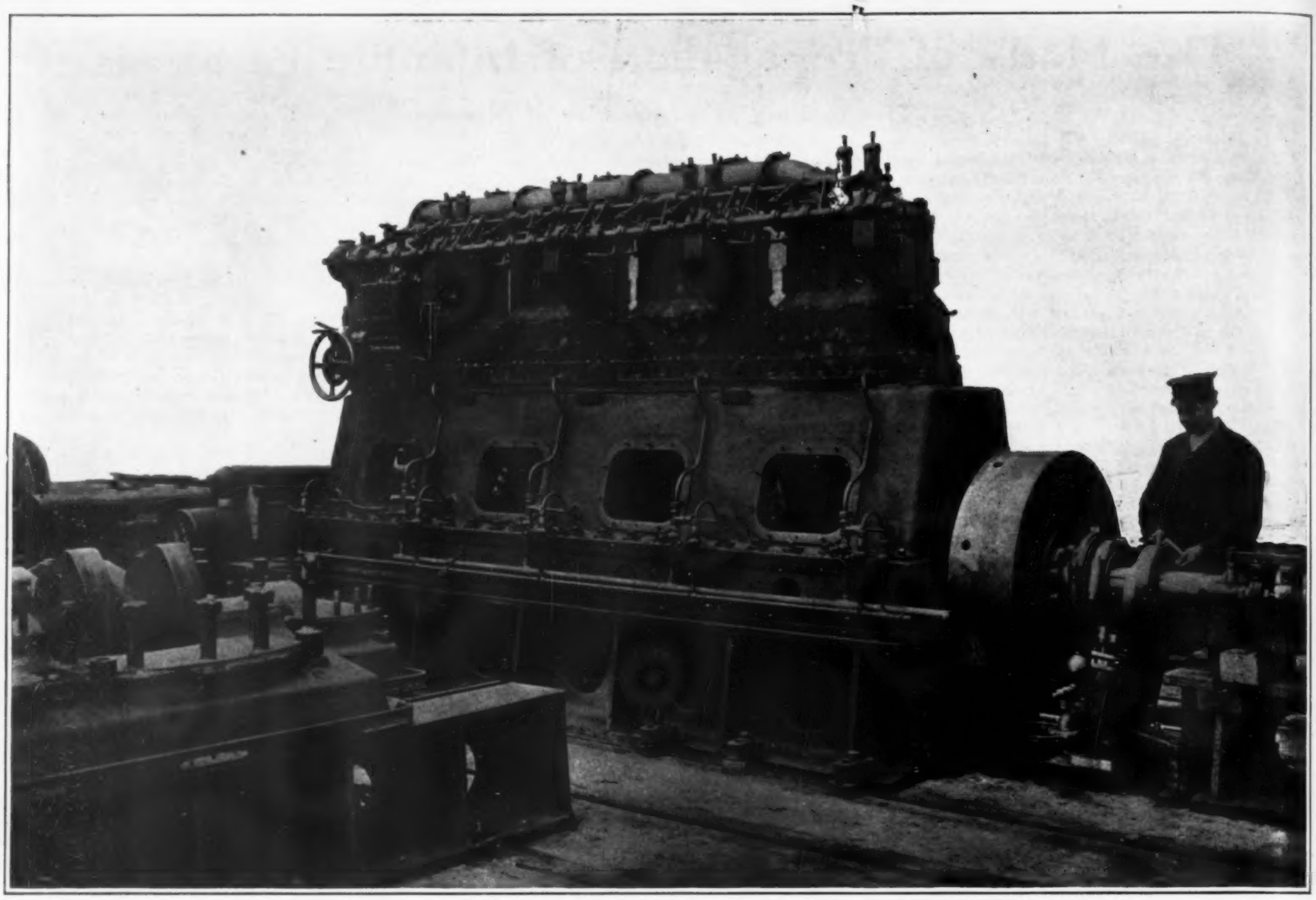


Fig. 1.—Three-hundred Horse-power Four-cylinder Oil Engine for Experimental Tugboat "Schlepp."

A High-Power Oil Engine for Tugboat Service

Another Step in the Spread of the Marine Diesel Engine

The accompanying illustration (Fig. 1) shows one of the recent high-power German marine oil engines of 300 horse-power capacity of the four-cylinder type as constructed at the works of the Aktien-Gesellschaft "Weser" in Bremen for the experimental oil driven tugboat "Schlepp."

The accompanying drawings (Figs. 2 and 3) show the details of construction of similar engines of the Diesel type built at Bremen having one and two cylinders, respectively, and developing 20 horse-power to 150 horse-power each for the former and 40 to 250 horse-power for the latter, and weighing from 14,300 pounds to 127,600 pounds. These Diesel engines vary in normal speed from 240 revolutions for the small units to 160 revolutions for the large units.

The crude oil consumption per horse-power hour with a fuel having 24,500 thermal units per pound, varies from 0.41 pound to 0.66 pound according to horse-power capacity and whether operated at ¼, ½, ¾ or a full load.

The continual increase in the use of oil engines for power purposes in German industrial plants and in agriculture, has justly directed attention toward this type of engine. The increasing price of fuel and the need of an engine which makes the most profitable use of the fuel, have favored the introduction of the oil engine, because, of all known prime movers, it is the one which works most efficiently from an economical point of view.

The following table shows the proportion of 100 thermal units converted into useful work in various engines employed at the present time and the distribution of the remaining loss of heat.

100 Thermal Units Give.

Driving Engine.	Useful Work.	Loss.	Friction.	The Loss Divides Itself Into: Cooling Water or Exhaust Condensation.	The Loss Divides Itself Into: Boiler or Generator.
Non-condensing steam engine.....	9	91	2.5	— 58.5	30
Engine for superheated steam with condensation.....	15	85	3	54 —	28
Suction gas engine	20	80	6	17 30	27
Weser oil engine..	33	67	10	27 30	—

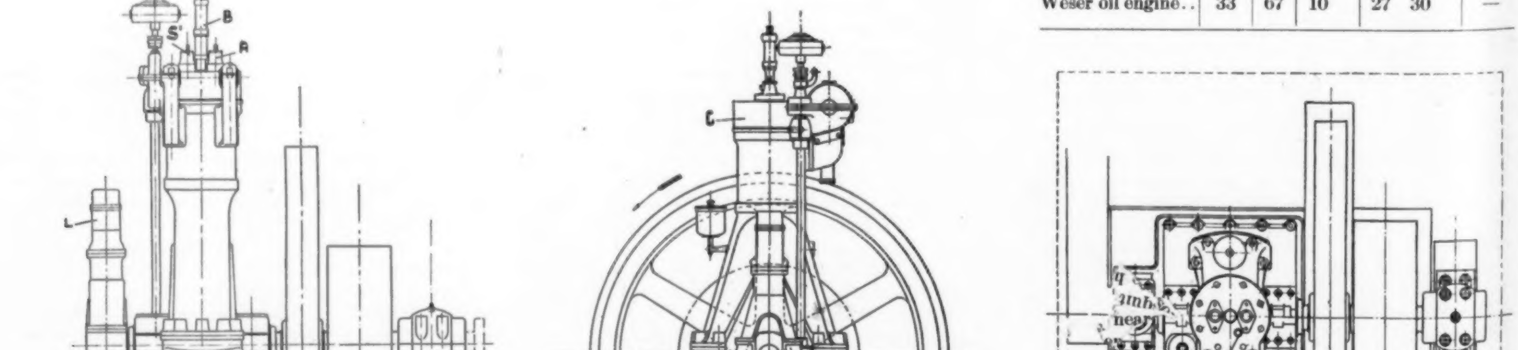


Fig. 2.—Single-cylinder Weser Engine.

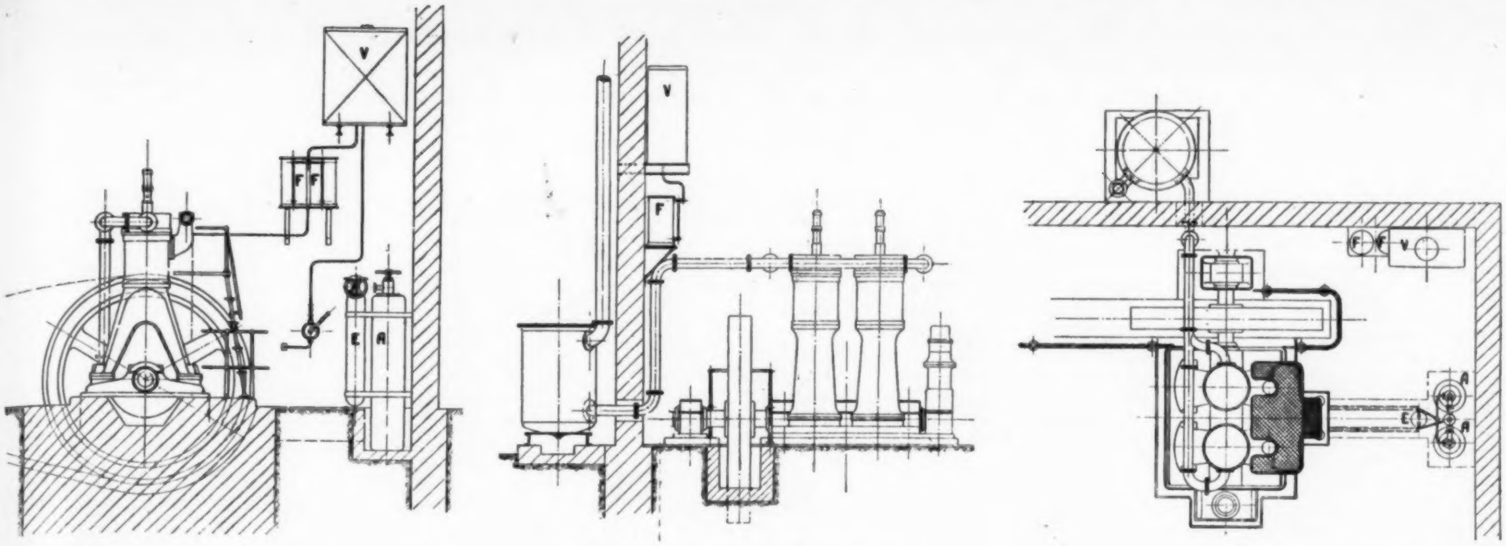


Fig. 3.—Two-cylinder Weser Engine.

It is pointed out that of the heat inherent in the motor oil 33 per cent and even more is converted into useful work by the Weser engine, whereas in the case of other engines this item amounts to only 9 per cent to 20 per cent. The Weser engine consumes 0.4 to 0.5 pound of motor oil per horse-power hour, which in the case of fuel with the average price of 90 cents per 100 pounds corresponds to about 4 to 5 cents per horse-power hour. When increasing the load with continuous working, the consumption of fuel per horse-power hour increases to a much smaller extent than is the case with all other types of engines.

The stationary Weser engine is of the four-stroke-cycle type. One side of the piston only closing one working space, work is done by every fourth stroke. The individual cycles of action are the following: At the first movement of the piston toward the crank shaft: Air intake. At the following movement of the piston away from the crank shaft: Compression of the air sucked in, whereby the latter becomes heated.

The second movement of the piston toward the crank shaft is the working stroke, with slow introduction and combustion of the fuel and consequent expansion. At the following movement of the piston away from the crank shaft the combustion gases are expelled. The introduction of the fuel is accomplished by a fuel pump which conducts the crude oil into the valve space of a fuel valve *B* noted in drawing (Fig. 2) whence it is injected by means of highly compressed air (higher than the pressure of the compression in the cylinder) during the working stroke into the cylinder space.

The introduced quantity of fuel is regulated by a regulator, according to the load of the engine. The air necessary for injecting, is obtained from the air pump *L*. This compressed air is also employed to start the motor.

The stationary oil engines of the "Weser" type are constructed vertically, the frame being cast in one piece with the cylinder and mounted on a common bed plate.

The working space is closed by the cylinder cover *C* noted in drawing (Fig. 2). The cylinder and cylinder cover are cooled by water; the latter is fitted with a suction valve S^1, a fuel valve *B*, an exhaust valve *A*, and a starting valve A^1.

All valves are in separate valve cages, ground into the cylinder cover. The valves are consequently readily accessible and each can be removed without difficulty. The valves are driven from a common cam shaft by means of cam disks and levers.

The fuel pump controlled by the regulator is also driven from the same cam shaft while the air pump *L* is a two-stage pump driven directly by the motor. The construction of the air pump valves is executed in the most scrupulous and accurate manner and permits a pressure production of up to 1,400 pounds per square inch.

The lubrication of the cylinder and piston pin is effected by a separate lubricating oil pump. The main bearings and cam shaft bearings are executed as lubricating ring bearings. All the remaining important parts are lubricated automatically from a central oil distributing vessel.

The construction of high speed engines differs essentially from that already described only by the fact that each individual part is built to correspond with the requirements of high speed working, while, as a rule, the lubrication of the main bearings and crank pin is accomplished by a separate pressure pump which continually forces the oil through all parts of the principal driving gear. The main bearings, on account of the high strain placed upon them, are here afforded an ample water cooling.

The accessory parts belonging to this complete two-cylinder oil engine may be noted in drawing (Fig. 3). The air plant consists of two starting receivers *A* and the tank for air supply *E*. The former contain the highly compressed air necessary for starting the engine, the latter the air for injecting the crude oil into the combustion chamber of the engine.

These air vessels are fed by air pumps. The crude oil plant consists of a storage tank *V*, which has a capacity sufficient for 10 hours working and is filled from a tank of crude oil stock by means of a wing pump operated by hand.

The filtering vessels *F* serve to repeatedly purify the crude oil; from there it flows to the fuel pumps on the engine. The cooling-water plant consists of a cooling-water pump driven by the engine by means of small belt pulleys. The consumption of cooling water per horse-power hour amounts to 2 gallons in the case of the large engines and up to 3 gallons in the case of small ones, with an inlet of 10 deg. Cent. and an outlet temperature of 70 deg. Cent.

The indicator diagram of this oil engine shows a constant fluctuation of forces without any sudden increase of pressure. The combustion is slow and noiseless and takes place without any shock, and consequently the wear and tear of the engine is insignificant and its durability is equal to that of steam and other power engines of the best construction.

The combustion of the crude oil is accomplished under theoretically perfect conditions of pressure and temperature. The effective utilization of the heat contained in the fuel rises as high as 35 per cent with an oil engine of this type. The engine consequently works cheaply and as a result of the perfect combustion causes no annoyance by smoke or smell of the exhaust gases, a very notable advantage when putting up plants in towns.

The governing is performed by changing the quantity of the fuel supply. The engine works without any shock and quietly under varying loads and consequently is specially adapted for driving electrical generators.

The starting of the engine takes place by means of compressed air, as the pressure necessary for the combustion must first be produced. The engine can be started in a few seconds without previously heating a boiler or producer and during interruptions in working no fuel is consumed.

The Problem of Selenium

The behavior of selenium toward light is one of the many familiar facts for which it is very difficult to find an explanation. Why this substance should conduct electricity better when light falls upon it and then come back to its first state when in the dark is a problem which has long puzzled physicists. The question is complicated enough in itself, and a further complication has arisen from the discovery of what are called abnormal selenium cells for which the effect of light is the reverse of the ordinary, that is, electric resistance increases when light falls upon them. Prof. C. Ries, a Greman scientist, has made some interesting experiments upon this action of light. These seem to show that the effect here is not of the same nature as in the ordinary case, nor is it due to similar causes. The negative or reversed effect seems to be produced by parasite actions among which moisture takes the main one. Some selenium cells are so sensitive to the moisture of the air that Dr. Ries could use them as hygrometers. Hence we need to operate in dry air or at least to have constant conditions of moisture if consistent results are to be obtained.

As regards the usual effect of light in lowering the electric resistance of selenium, the various theories proposed by Hesehus, Weigel, Berndt, Marc, Schrott, Pfund, Kruyt and others, may be divided broadly into two classes. According to theories of the first kind selenium exists in two allotropic forms which are in equilibrium. The first form, or *A*, is produced by melting selenium at a low temperature (about 130 deg. Cent.). This is known as the vitreous or shining form, and resembles sealing wax. It is almost a perfect non-conductor. By heating it at 200 deg. Cent. for a long time it turns to the *B* state and is now of a dull gray color, conducting electricity and sensitive to light. This is the form which is seen in selenium cells. According to one theory, the heating produces a solid solution of one kind in the other, tending to produce more of the *B* kind, so that light has the same influence as heating. But Dr. Ries thinks that such a theory is open to many objections, since it is known that light does not cause any appreciable heating of the selenium, so that heat cannot here be producing a chemical change. It is found that at —185 deg. Cent. selenium is almost as sensitive to light as usual, and this result seems to preclude any theory which ascribes the effect to chemical action, for at such extremely low temperatures chemical action is almost wholly suspended. It is not clear either how the form *B* could come back to form *A* when returned to the dark. Recently Agostini and Berndt found that electrical waves act in the same way as light, so that a chemical action due to a heating effect does not seem probable.

Dr. Ries thinks that the second theory, which assumes a purely mechanical action, is much better. Wilson's experiments show that dry iodide of silver when acted upon by ultra-violet light gives an electric discharge, while violet rays have no effect. On the contrary, the electric resistance of the iodide is affected almost exclusively by the violet rays, and toward the ultra-violet there is no response. Thus we are led to think that the former electric effect is due to the tearing off of electrons under the action of the ultra-violet rays. Such rays will excite great resonance effects in the mass of a substance such as selenium and cause it to send off corpuscles at a high speed. Ordinary light shares this action somewhat, but here the speed is much less and the corpuscles are not sent off but remain within the mass and may increase its conductivity. But with most metals, which are good conductors, and have a good number of free electrons in the normal state, such action is not felt. Selenium being a poor conductor, is, according to this theory, much affected by light for this reason.

The Cause of the Souring of Milk in Thunderstorms —Everybody is familiar with the fact that milk is more apt to turn sour in stormy weather than at other times. The cause of this has been a matter of considerable mystery, but some light seems to be shed on the situation by A. Trillat, who has shown that minute traces of gaseous products of putrefaction favor the development of lactic ferments. Hence, any fall in atmospheric pressure which encourages the liberation of such gases from various sources will indirectly assist the souring of milk, and, for the matter of that, the decay of various putrescible materials. That such liberation of gases does actually occur at times of barometric depression is rendered manifest enough by the characteristic smell which the earth is found to exhale at such times. Mr. Trillat has, moreover, positively confirmed his theory by exposing samples of milk in the neighborhood of substances giving rise to putrefactive gases. On diminishing the pressure, so as to cause the liberation of the gases, it is found that the milk is apt to turn sour.—*Cosmos.*

The Present Status of the Diesel Engine in Europe.—I.*

And a Few Reminiscences of the Pioneer Work in America

By Dr. Rudolph Diesel

Since its first appearance in 1897, the Diesel engine has been built by the thousand in the best factories of all industrial countries. It has been proved to be a most reliable engine when properly built, and to-day the thermal or indicated efficiency reaches 48 per cent in this engine, and the effective or brake efficiency reaches in some cases 35 per cent of the heat value of the fuel.

The Diesel engine is the engine which converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and which utilizes it as far as the present standard of science permits; it is, therefore, the simplest and at the same time the most economical prime mover.

These two facts explain its success; it lies in the new principle of the internal working process and not in constructional improvements of alterations of older types of engines. A further reason for this success is that the Diesel engine has broken the monopoly of coal, and has solved the problem of using liquid fuel for power production in its simplest and most general form. It has become for all liquid fuels what the steam engine and gas engine are for coal, but in a much simpler and more economical way. The truth of this statement was strikingly proved at the Turin exhibition of last year. At this exhibition, in the large Machinery Hall, a steam turbine and a large Diesel engine, both made by Franco Tosi of Milan, and set up on the same stand were worked together with the same liquid fuel. The boilers belonging to the plant were fitted with Koerting nozzles for burning crude oil. The difference between the two plants was, therefore, this: For the working of the steam engine, the whole boiler plant with its chimney, full supply apparatus, purification plant for feed water, with feed pumps, extensive steam pipes, condensation plant, with water pumps, and an enormous water consumption, had to be provided, with the final result of consuming two and one-half or more times the fuel per horse-power required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke.

Thus, the Diesel engine has doubled the resources of mankind as regards power production, and has made new and hitherto unutilized products of nature available for motor power. The Diesel engine has thereby exercised a far-reaching influence on the liquid fuel industry, which is at the present time advancing more rapidly than was previously conceivable. This is not the place to discuss this matter in detail, but I wish to mention that, owing to the interest which petroleum producers have taken in this important question, new petroleum sources are continually being developed, and new oil districts discovered. Moreover, it has been proved by recent geological researches not only that there is probably on the globe as much, or perhaps even more liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position. These facts, which are indisputable nowadays, have gradually silenced those who objected to too great a development of the Diesel engine for fear of insufficient stores of liquid fuel.

That the auxiliary industries of petroleum production are also considerably influenced is shown by the great increase which the transport industry for liquid fuel has experienced in recent times, especially the great development of tank vessels which are, or will be mostly driven by Diesel engines.

But with all this, the influence of the Diesel engine in the world's industries is not exhausted. As early as the year 1899 I utilized in my experimental engine the by-product of coal distillation and coke plants, such as tar, and creosote oils, with the same satisfactory results as with natural liquid fuels, but at that time the quality of these oils was generally too inferior for their use in the Diesel engine, and it was, moreover, subject to continual variations. It is only in recent years that the chemical industries interested in the matter have, by improved methods of fractioning and refining, combined with more careful selection of the material, succeeded in supplying fuel of a constant and regular quality without the drawbacks of the crude tar oils used previously. These products—the tar and tar oils—are thus to-day definitely brought into the sphere of activity of the Diesel engine.

This fact is, perhaps, not of so great an importance for the United States on account of its richness in natural oil, but it is of the utmost importance for European countries and especially for those countries which do not have an oil production of their own, and it may be of some interest to state that, for instance, the tar production of Germany is sufficient for more than five milliards of horse-power hours per year, which means about one and three-quarter millions of horse-power running 300 days for 10 hours each all the year. In case of war cutting off the supply of foreign fuel, this quantity would be sufficient for running the whole fleet, war and mercantile, and for providing in the meantime the power for the inland industries as far as necessary.

From what has been just stated, it will be seen that the Diesel engine is having an increasing influence on two other industries, the manufacture of gas and coke, the by-products of which have become so important for power production that an enormous business is at present connected with them. It is especially noteworthy that every town gas works of modern construction, and every coke works can be arranged to generate electric power by using its tars in Diesel engines, and one fact stands out clearly in this connection, namely, that coal which seemed to be most threatened by the liquid fuels will, on the contrary, gain a new and wider ground of application through the Diesel engine. As tar and tar oils are from three to five times better utilized in the Diesel engine than coal in the steam engine, a much better and more economical utilization of coal is obtained if, instead of being burned under boilers on grates in a wasteful way, it is first transformed into coke and tar by distillation. Coke is used in metallurgical and other general heating purposes; from a part of the tar the valuable by-products are first extracted and undergo further processes in the chemical industry, while the tar oils and combustible by-products, and a great part of the tar itself are burned in the Diesel engine under extraordinarily favorable conditions.

It is evident that these circumstances are of unequal importance and value for different countries, of which some are exclusive coal countries, others exclusive oil countries, and others again mixed coal and oil countries, like the United States. It is difficult to predict what development will take place in a given country, but it is certain that the possibility of burning the by-product of gas works and coke ovens in the Diesel engine has had in Europe the consequence of making the different countries independent as regards their supply of liquid fuel, by preventing the increases of price for the natural liquid fuel and the establishment of trusts or monopoly companies. This condition is now reached in Europe, where we have definitely broken the monopolies in liquid fuel oil, not by laws or artificial means but by the invincible force of scientific investigation and industrial progress before which the mightiest of us has to bow.

From what has been said, the following statement may be made: The proper development of the utilization of fuel which has already been started and is now making rapid progress is this: On the one hand liquid fuel in Diesel engines, and on the other hand, gas fuel also in the form of gasified coke in the gas engines; solid fuel as little possible for steam power generation, but as much as possible in the refined form of coke for all other heating and metallurgical purposes.

It is not generally known that it is also possible to burn vegetable oils and animal oils in the Diesel engine without any difficulty. I made the first trials with earth-nut oil at the Paris Exhibition in 1900, and have since then repeated them with castor oil and palm oil, and also with animal oils. The use of vegetable oils may seem insignificant to-day but such oils may become in course of time of the same importance as some natural mineral oils and the tar products are at the present time. One cannot tell what part these oils will play in the colonies of the future. In any case, they make it certain that motor power can still be produced from the heat of the sun, which is always available for agricultural purposes, even when all our natural stores of solid and liquid fuel are exhausted.

To be continued.

* Paper read before the American Society of Mechanical Engineers, April 30th, 1912.

The Ether*

A Summary of the Evidence For and Against Its Existence

By P. G. Nutting, Associate Physicist, Bureau of Standards

The whole of theoretical ether-physics has been profoundly modified within the past two decades. Many of the fundamental concepts of electricity, gravitation, radiation and even matter itself have been revised from their foundations. Our task to-day is to examine the storm center, the ether. In anticipation, it may be stated that the task will prove not to be a mortuary one, but rather one of removing and getting rid of rubbish. The new ether is the old ether freed from useless and incongruous attributes.

What we wish to know about the ether is whether it exists or not, what are its nature and properties, and what are its relations to electricity, gravitation, radiation, induction and chemical affinity. Material bearing on these problems is scanty and we can do little more than review the experimental facts and their interpretation, contrasting their present interpretation with that of twenty years ago and placing in their proper setting the more recent important discoveries.

First then as to the *existence of the ether*. We shall discuss first the evidence in favor of an ether and then sum the evidence against it. The older reasons for supposing existence of ether hold as forcibly as they ever did and to these have been added new ones of some significance.

1. There is the old question of *action at a distance*. Wherever two objects are attracted toward or repelled from each other and there is no material connecting link such as a wire or pulsating fluid, between them, it has always been customary to put the burden upon an immaterial medium. Gravitational attraction, electrical and magnetic attraction and repulsion are of this nature. Chemical affinity should probably be included but some hold that a material link actually holds the atoms together.

In my opinion not much weight can be attached to action at a distance as evidence for the existence of an ether. The assumption of an ether is doubtless the *simplest* explanation of the facts, but it is certainly not the *only possible* explanation. It is easy to imagine an intervening medium pulled by one body and itself pulling a second body. However, in imagining such a medium, we are endowing it with mechanical properties and with such extreme properties as no known material possesses. In discarding the mechanical assumption we may either assume a non-mechanical ether or else assume that these forces really belong to some higher mechanical system in which the apparent action at a distance is in reality contact action. Perhaps there are still other alternatives. I merely cite these two to show how far we are from a final disposition of the problem.

2. The *propagation of electromagnetic energy* from one body to another. Radiation is emitted by one body and received after an interval of time by another. Where and what was this energy during that interval of time? Until recently, these questions were readily answered: radiation travels as wave energy, where waves are there is *motion*, where motion is there is something that *moves*, namely, the ether. At present with an ether devoid of mechanical properties, there are wide differences of opinion as to just how electromagnetic energy travels through space, but if we knew how it is propagated through any material di-electric, we could very probably give at least a tentative explanation of how it travels from one body to another.

So far as we now know, such energy could be propagated through *void* space only in corpuscular form. If we assume corpuscular light, we have to contend with a solid array of firmly established facts. Further, electromagnetic theory itself shows that energy thus propagated is essentially *alternating* in character and in definite relations to the direction of propagation. To my mind, all the evidence afforded by the propagation of radiation through space is against that space being void and in favor of an ether with very definite electric and magnetic but without mechanical properties.

3. A third group of evidence bearing on the existence of the ether consists in those phenomena indicating a storage of energy in the neighborhood of an electric

* Paper presented before the Physics Association of the Bureau of Standards, February 5th, 1912, and published in the *Journal of the Washington Academy of Science*

charge in actual motion. These phenomena correspond with self induction in the case of ordinary electric currents. Cathode ray particles, the Beta particles from radium and similar objects carrying electric charges with high velocities, carry more energy than corresponds with their material mass and velocity, electro-magnetic energy of the adjacent medium. This may even be separated from the matter and charge and measured as energy in the form of Röntgen or of Gamma rays.

These phenomena, to my mind, supply the most direct evidence of the existence of a medium. If there were no medium how could a moving charge carry or conduct along with itself, *outside itself* energy of motion. How could a bullet moving in void space possess energy of motion exterior to itself? It may be thought that the assumption of lines and tubes of force as physical entities would provide an escape from the assumption of a medium. But such an assumption merely displaces the dilemma. If we consider that the region adjacent to a moving charge is filled with actual tubes of force instead of merely being an electromagnetic field, how, without a medium, could the sizes and shapes of these tunes be a function of the velocity of the charge?

4. To most of us it is a significant fact that not one of those whose work has been largely instrumental in the overthrow of the mechanical theory—H. A. Lorenz, Poincaré, Planck, Larmor, J. J. Thomson, Schuster, Whittaker, Heaviside, Wiechert, or Michelson—appears to question the existence of an ether *without* mechanical properties.

The no-ether school may fairly be compared with the no-atom school of Energetics. If we ignore the ether or the atom we may treat a considerable portion of physics quite satisfactorily but we must ignore a great many vital and significant phenomena in so doing.

The evidence *against* the existence of the ether falls into two distinct classes; it is either evidence against the *mechanical* theory or else evidence based on the negative results of attempts to detect ether drift. In the last analysis these two are the same but we shall discuss them separately.

The mechanical theory never did have high standing with thinking men, and but for the support of a few leading physicists having mechanical minds, would never perhaps have been developed beyond a mere tentative hypothesis. We have no reason to think that even Lord Kelvin himself, chief exponent of the mechanical theory, ever considered it more than such a working hypothesis.

We are all familiar with the character and properties assigned to the mechanical ether; its enormous elasticity and infinitesimal density to give the proper value to the velocity of light, its enormous tensile strength to support gravitational forces, its solid properties to propagate transverse light waves, its fluid properties to permit heavenly bodies to move through it with fixed velocities, and so on. The mechanical ether reached its highest development as a vortex sponge at the close of the last century. It has passed away, not by violence but by starvation. It always was a monstrosity and we are only too glad to be able to discard it forever.

The stubborn refusal of all phenomena, both natural and artificial, to show any indication of absolute motion in space has no direct bearing on the question of the existence of an electromagnetic ether. The Lorenz contraction hypothesis, with the electron theory of matter, offers us one loophole of escape from the stubborn facts, the relativity theory several. It is too early to say what will be the outcome, into what framework of theory, our experimental facts will fit with least violence to themselves.

Some relativists would have us reject the ether entirely on the ground that it is useless. I, myself, fail to see how it can be dispensed with, any more than atoms or molecules can be dispensed with, nor how anyone, at all versed in theoretical optics or electricity, can consider it unnecessary.

In short, the mechanical ether of Kelvin, Lodge and Helmholtz, the ether most of us were brought up on, has been proven untenable, the electromagnetic Maxwell ether stands just where it always stood. It has been attacked, without much effect, by the extreme relativists, strengthened by the electron theory and brought into prominence by the pruning away of the mechanical theory.

As the conservation of energy is the simplest general principle which will make perpetual motion impossible, so the simplest physical law that will permit of discarding all the mechanical attributes of the ether is the principle of relativity. Each of these principles are, however, but limited forms of more general laws.

Before outlining the properties of the ether let us consider briefly its mathematical framework in the newer physics of which the relativity theory is the most conspicuous landmark. Mathematical physicists (Lorenz, Minkowski, Abraham, Einstein) have found that apparent experimental contradictions disappear and the mathematical framework of physics is greatly simplified if, instead of referring phenomena to a set of three space axes and one time axis of reference, they are referred to a set of *four* interchangeable axes involving four homogeneous co-ordinates, three of space and one of time. There are an infinite number of ways of projecting the four dimensional (x, y, z, t) space into the x, y, z, and t space.

Phenomena that are ambiguous and contradictory when one projection is used are simple and harmonious with another projection. Furtner, if a star, say, is in motion relative to one x, y, z, t system, it will be at rest with respect to some other system of axes. Relativity is a particular instance of the application of these principles. Already gravitation, that most recondite of all physical facts, is yielding to this four dimensional analysis. What we have here to keep in mind is that in order to explain the lack of ether drift it is unnecessary to annihilate or ignore either space or time intervals but merely to generalize our axes of reference.

Three classes of physical phenomena may take place within or across space void of matter:

(*a*) *Forces* may *act*. Electric, magnetic, gravitational (and possibly chemical) forces act across space even when no matter intervenes. Electric and magnetic forces may be either positive or negative, gravitational and chemical forces are negative only. The signs of these forces can not be altered by any intervening medium. Electric forces are a maximum when no matter intervenes. Magnetic forces are intermediate in value while gravitational force is the same whatever the intervening medium. The speed of propagation of electric and magnetic forces across space is a finite constant independent of the sign or magnitude of those forces. The speed of propagation of gravitational forces is certainly greater than 10^{14} cm/sec and probably infinite. In no case is there any evidence of a force too small or too great to be propagated; that is of any finite maximum or minimum load. In other words, there is no evidence that the ether, if the ether be responsible, has any finite inertia or viscosity on the one hand or breaking strength on the other, certainly not in any mechanical sense.

(*b*) The absence of matter is no bar to *induction*. An electric charge induces an electric charge as readily across a vacuum as through matter, and similarly with magnetic and electromagnetic induction. Induction is always of the same sign, unlimited in magnitude and propagated with the speed of light.

(*c*) Electromagnetic radiation is propagated across a vacuum as freely as through matter. Beams of light and electric waves, whatever their nature, travel independently of each other, i. e., no matter how filled with radiation of *one* kind and direction a certain space is, neither the wave length, velocity, direction, damping or polarization of any other beam traversing the same space at the same time is in any way affected. Neither electric nor gravitational *strain* of any amount produces birefraction in a space devoid of matter nor does a magnetic field affect the *plane of polarization* unless matter be present. That these effects do exist in matter indicates an actual mechanical strain. Of the two astronomical methods for determining the velocity of light, the satellite method gives the *group* velocity, while the aberration constant gives the *wave* velocity; the close agreement between the values obtained indicates that wave and group velocity is the same, hence that there is *no* dispersion in space, waves of all frequencies travel with the same velocity.

Two important facts give us clues to the actual magnitudes of the constants of the ether (*a*) the fixed finite nature of the velocity of propagation (independent of the motion or intensity of the source) indicates definite electrodynamical properties in the space traversed, in fact that

$$c = (k\mu)^{-\frac{1}{2}}$$

We but require a second independent relation between c, k, and μ to determine the actual values of k and μ for the ether. (*b*) Again, space has a definite fixed *capacity* for radiant *energy*, a function of the frequency of the radiation, its spectral distribution, the velocity of propagation and the amount already present. Expressions for what correspond with entropy and specific heat may be derived without difficulty. This capacity for energy is dependent upon boundary conditions while the velocity constant is *not*.

There exists rather conclusive evidence that short wave and pulse electromagnetic energy is emitted in even multiples of a small but finite quantity proportional to the frequency. On the other hand there is no evidence that such is the case with the long waves of wireless telegraphy. However, it does not follow that even light waves or Gamma rays are necessarily propagated in space in these discrete units. A spherical wave or pulse may be subdivided radially by an absorbing screen, a lens or a mirror; tangentially by partial absorption or reflection or by double refraction and there is no evidence of any limit to the attenuation a pulse or wave may suffer during propagation.

To summarize the properties of the ether we may say that it has no *mass* and no *rigidity* in the mechanical sense and that its parts have no *identity*. Having no mass it can have no *density*, having no rigidity it cannot be subject to *strain*. The ether does, however, possess electromagnetic properties analogous to each of these.

Having no identity, its displacements and velocities, if it has any, are unknown to us. Tagging the ether with electromagnetic disturbances is, as we have seen, ineffective. The core of the matter is this: What kind of a medium can have *real tangible* forces acting at its boundaries and conduct real energy with a finite velocity and yet itself have no inertia or rigidity in any mechanical sense.

Two of the many possible explanations are suggested. (1) the properties of the ether may be mechanical after all but in four dimensions. If this be the case it is for the mathematical physicist to work out the solution of the problems of gravitation, induction and radiation; it would be useless for the experimental physicist working in three dimensions to seek a solution. Or (2) the properties of the other may be non-mechanical of unknown nature. In this case, it is for the experimentalist to find out the nature of electricity and ponderomotive electrical effects. The four dimensional mathematical method appears to be the only one capable of attacking the gravitational field; yet we feel instinctively that the final solution *must be* physical and three dimensional.

Trespassers Killed on Railways*

See Page 2-38

Who Are They?

By Frank V. Whiting, General Claims Attorney, New York Central Lines

RECENT writers have stated that probably there are no fewer than 500,000 tramps in America. When we realize that they arrive at this number by taking as a basis the number of trespassers on railways killed, and multiply this by the figure representing the proportion of trainmen killed in a year to the total number of trainmen employed, we see how unreliable such figures are. As a matter of fact, trespassers come from all walks of life, and the statement that was recently made by Orlando F. Lewis, that from one half to three quarters of trespassers are vagrants, is without foundation. Mrs. Alice Willard Solenberger, in a book recently published by the Russell Sage Foundation, entitled "One Thousand Homeless Men," criticises the customs of railway officials in designating as "tramps," that very large body of men that "beat" their way about the country, and she refers to thousands of *bona fide* workmen, who, at certain seasons of the year are needed in a particular section of the country in large numbers. She states that these seasonal and shifting workmen are not tramps and should not be classed as such; and neither should other men, who with a legitimate purpose are on their way to a known destination, nor should those others who are only accidentally or quite temporarily upon the railways be so classed. She further states that to class these men as "tramps" is not only unfair to the men, but confuses the discussion regarding either homeless men or tramps. From her investigation she decided that 220 out of 1,000, or less than 25 per cent, were tramps.

Being impressed with the lack of information on the subject, and also by the assertions made with regard to tramps on railways, I deemed it profitable to secure some authoritative data, and to this end have examined reports of accidents resulting in the deaths of 1,000 trespassers. The results are interesting as well as enlightening.

It is many years since the word "tramp" escaped from the vocabulary of most railway officials, and was superseded by that very sentient substitute, "hobo." A tramp means one who walks from place to place, either idly or in search of work; specifically, "an idle wanderer." "Hobo" is defined as an idle, shiftless, wandering workman, ranking scarcely above the tramp.

Among most railway men the hobo is a typical tramp, especially to those who come in contact with the trespasser problem through the investigation of accidents resulting in injury or death of persons generally. However, neither the word "tramp" nor "hobo" is used, except in a very restricted sense, when applied to some person who is in fact a hobo or tramp. These words, how-

* Reproduced from the *Railway Age Gazette*.

ever, are not used to designate that large class of persons who walk upon the tracks or "beat" their way upon railway trains, but such persons have for years been classed as trespassers.

The Interstate Commerce Commission reported that during the fiscal year ending June 30th, 1911, 10,396 persons were killed upon railways, and this number includes those who were instantly killed or died within twenty-four hours from the time of accident. Of these, 5,284 are designated as "trespassers." It is a significant fact that, of the number of trespassers killed, practically 80 per cent or 4,125 are shown as having been "struck by engine or car," in other words were walking or standing upon the tracks; 520 were killed in "getting on or off cars and engines," 1,043 "while on trains," and 116 from "other causes."

There are many trespassers on the tracks of railways who are regularly employed and who make it a practice to use the right-of-way between streets or highways in going to or from their work. The tracks are also used to a considerable extent by pedestrians when public highways are wet and muddy, or difficult to walk upon.

We found that of 1,000 persons killed while trespassing, 489 resided near the place of accident; 321 resided at a place distant from where the accident occurred; and the residence of the balance, 190, was not ascertained.

The conjugal state of the decedents has some bearing upon this question; and it is interesting to note that of these trespassers, 273 left widows or children, 33 were widowers, 376 single, and the family connection of 318 unknown. Further, 369 were living with their families or parents, 301 were not living with their families or parents, and 330 could not be classified in this respect. When we consider that many young men employed in our larger cities have left home and are boarding, and that among the trespassers there is quite a number of foreigners who come to this country without their families, it is not strange that so large a percentage should be found not living with their families or parents. Another thing that indicates clearly that the large majority of trespassers are not tramps in any sense of the word, is that 598 of the thousand referred to were self-supporting (388 were known to be regularly employed), and 105 were not self-supporting. This information was not obtainable as to the balance.

The age by groups are of interest: 68 were 15 years and under; 340 were 16 to 30 years old; 451 were 31 to 60 years old; 69 were over 60 years old; 72 were of unknown ages, all these being adults.

With reference to nationalties we found that 468 were Americans, including 3 Indians and 18 negroes. In 174 cases the nationality was not reported, but in the rest we find that no less than twenty-four foreign countries contributed their quota to this regiment of trespassers who trespass no longer.

The occupations of those killed and the number employed in each warrants detailed mention. These were as follows:

349 Unknown.	3 Nurseymen
19 None.	81 Shopmen and mechanics.
70 School children and students.	2 Barbers.
268 Laborers.	1 Contractor.
44 Farmhands.	3 Bakers.
1 Minister.	2 Messengers.
1 Actor.	5 Soldiers.
1 Inmate asylum.	8 Sailors.
10 Engineers.	31 Railway trainmen and other employees.
1 Chemist.	3 Musicians.
4 Clerks	1 Teacher.
6 Hotelmen and bartenders	2 Fishermen
18 Merchants, salesmen and agents	1 Patrolman..
	2 Shoemakers.
2 Coachmen and chaffeurs	4 Horsedealers.
	4 Lumbermen.
3 Linemen	3 Watchmen.
3 Cigarmakers	8 Miners.

Then, there were in addition six small children and thirty women.

It is thus readily seen that not only from more or less actual knowledge, but by a definite process of elimination we learn that many of these unfortunates were neither tramps nor hoboes, and, in fact, we are justified in saying positively that 764 were not hoboes and 50 were, and that the status of the rest was not determinable.

Deaths are occasionally brought about by intention on the part of the decedents, and the information at hand shows that 15 of the cases were reported as suicides. Intoxication contributed to a large extent to the number of deaths, there being 93 cases reported due to this cause; at least the men killed were intoxicated at the time. In 708 cases the trespasses were not intoxicated, and in the rest the condition in this respect was not known.

Mrs. Solenberger says: "It is the mere accessibility of the railways more than anything else, I believe, that is manufacturing tramps to-day. So long as it is possible for practically any man or boy to beat his way about the country on the railways, we shall continue to have tramps in America. When we succeed in absolutely closing these highways to any but persons having a legitimate right to be upon the them, we shall check at its source the largest single contributory cause of vagrancy, and the problem of the tramp, as such, will practically be solved. As an unemployed, untrained, sick or irresponsible homeless man he will still need attention, but this can be given him with incomparably less difficulty when once he is deprived of the facilities he now has for wandering from one place to another."

Considerable has been said of late with reference to laws against trespassing. Very few of the States have laws specifically directed against trespassing on railway tracks, and usually laws with reference to trespassing on trains are mild in form and not very often enforced. A great deal of difficulty has been experienced from time to time in getting magistrates to prosecute offenders in this respect.

Mrs. Solenberger suggests: "If the migration of tramps could be controlled, as already suggested, under some sort of federal interstate commerce law, the problems might perhaps be solved, but it is most likely that these vagrants can be dealt with by the national government until long after individual States have discovered how best to deal with them locally. Students of the problem now generally believe that little progress can be made by any State until the responsibility for the treatment of the tramp is assumed by the State as a whole; until the laws which affect him are State laws; until the cost of his arrest and punishment or treatment is met by the State, and not by counties or cities within the State."

It has been suggested from another source that Congress pass a law prohibiting trespassing on interstate railways; and this suggestion is an excellent one and should receive serious consideration.

However, it is evident from the information shown above that, after all, the problem is not so much one of dealing with tramps or hoboes, but with trespassers, who in many instances are regularly employed, well-to-do and respected citizens of our towns and cities, and that so far as the prevention of accidents to trespassers is concerned, the problem is largely a local one and wholly within the hands of the local authorities.

Bleaching Powder as a Substitute for Soap.—Dr. G. F. Sacher, in an article in *Soziale Medizin u. Hygiene*, recommends the use of bleaching powder as a cleansing agent for the hands of the working man as a preventive against metal poisoning. Workmen handling metals, such as lead, mercury, antimony, arsenic, bismuth, zinc, chromium or manganese, either in metallic form or in the form of compounds, are constantly exposed to the danger of poisoning, through imperfectly cleaned hands. Small particles may thus be transmitted to the mouth in eating or smoking. To completely remove metallic impurities from the hands is not always an easy matter; soap alone is in most cases well nigh useless as it forms insoluble compounds with most of the metals. Bleaching powder, however, is an ideal material for the purpose stated. It has no injurious effects on the hand or the blood, and may, therefore, be used even on chapped hands. It forms a lather like soap, and acts chemically as well as mechanically, thus removing any metallic impurities or compounds in the shortest time possible. It further has the advantage over soap of having strong disinfecting properties.

Fire-proof Paints.—On this subject the *Farbenzeitung* has some important information. To render readily combustible material (wood, cardboard, paper, etc.) difficult of ignition we have recourse either to impregnation or to a protective coating. Before wood can be impregnated it must be exhausted of air; the fluid is then forced into it under a pressure of eight atmospheres. For this purpose, water glass, salts of ammonium and tungsten, find extensive, alum, boracic acid, chloride of zinc and sodium phosphate a more limited use. Girard recommends, as the best impregnating fluid, a solution of 100 parts phosphate of ammonium and 10 parts boracic acid in 1,000 parts of water. Coating can also furnish fair protection. As coatings the following mixtures are used: Dissolve in 60 parts of water, 15 parts of borax, and 15 parts of Epsom salts and add color as desired; or use a solution of 14 parts sulphate of ammonium, 10 parts borax, and 25 parts glue in 80 parts of water. Very suitable is likewise a mixture of 100 parts of gypsum with 50 parts sulphate of ammonium and 150 parts of water. By the addition of dissolved walnut stain, colored coatings may be obtained. If the coatings are to have covering properties, a mixture of 15 parts of asbestos, 10 parts of clay, 5 parts of borax, 5 parts of water glass, and 15 parts of water is recommended. The asbestos and the clay, which must both be ground very fine, are first mixed and then thoroughly stirred with the solution of borax and water glass, the whole being applied warm. Other fire-proof coatings are obtained by mixing 100 parts heavy spar, 5 parts zinc white, 100 parts water-glass solution (30 deg. Bé.) and 80 parts water in the hopper mill, or by mixing 70 parts of zinc white, 30 parts of hydrate of lime, 10 parts water glass, 50 parts white lead, 10 parts zinc vitriol, and as much water as desired, also in the hopper mill.

Science Notes

The Pigment of Egg Yoke.—The German chemists, Willstraeder and Esch, have isolated a crystalline product, which represents the pigment of egg yoke. It is interesting to note that this turns out to be closely related to so-called xanthophyll, the pigment of green leaves. Something of the patience of the workers may be gathered from the fact that they had to treat no less than 6,000 hens' eggs in order to obtain 4 grammes of the pure pigment.—*La Nature.*

Austrian Radium Monopoly.—According to the *Neues Wiener Tageblatt*, the Austrian State is about to purchase Count Sylva Tarouca's pitch blende mines in the neighborhood of Joachimsthal for 2,250,000 kronen ($457,000). This purchase would give the State a practical monopoly of the radium production in Austria, if not in the world, inasmuch as the radium yielding pitch blende deposits in other countries are insignificant in comparison with those of the Joachimsthal district, where it is hoped in future to produce as much as five grammes of radium per year.

"Eyes" of Snails.—We are all familiar with the peculiar stalked structures which the common snail protrudes from its head as it travels along, seemingly exploring the territory around by what we are accustomed to describe as "eyes," situated at the end of the stalk. According to a note published in *La Nature*, this is a misapprehension. It appears that if the ends bearing the so-called "eyes" are cut off these stalks, the snail after a little while proceeds on its way in exactly the usual way, thrusting out its tentacles and behaving much as before. It is, therefore, doubtful whether this eye has any visual function at all. It seems rather that the tentacles, by touch or in some other way, inform the snail of the presence and character of neighboring objects.

Resistance to the Tropical Sun.—Hans Aron, writing in the *Philippine Journal of Science*, tells us that animals whose capacity for thermal regulation is limited, such as rabbits and monkeys, rapidly succumb to exposure to the tropical sun. Autopsy in such cases shows hemorrhagic lesions of the meninges, sometimes of the heart. Under the same circumstances, the skin of a man rises some three or four deg. Cent. above the normal. Theoretically, the black skin of negro races should absorb more heat than that of the white people. However, colored races are better able than the white to regulate their temperature under the influence of the tropical sun, perhaps because perspiration is more abundant. The ape, although a native of the tropics, is less capable of resisting the sun than other animals and even the white man. This is no doubt attributable to the fact that its natural habitat is in the forests; for certain monkeys two hours of exposure to the tropical sun is fatal.—*La Nature.*

Dry Air for the Treatment of Wounds.—It is a matter of common knowledge among the initiated that in the tropics even severe wounds heal with remarkable rapidity. The cause for this phenomenon is not completely explained. It cannot be ascribed merely to the heat, for in our latitudes we do not experience any advantage of this kind during the summer. The active factor must be the great dryness of the air, and indeed experience teaches us that very few bacteria are capable of living in dry air. The idea very naturally suggests itself to apply specially dried air for the treatment of wounds, catarrhs, etc. An apparatus for this purpose has recently been constructed by Dr. R. Kutner, and is described in *Prometheus*. The air is passed through a number of flasks, of which the first contains paraffine oil, serving merely for washing the air. The second and third flasks contain pumice soaked in strong sulphuric acid, and lastly, two flasks are provided with a charge of lime and caustic soda. If desired, suitable medicinal vapors may be added to the air, which may also be heated, a thermometer indicating its temperature. A blast of air may thus be directed to any portion desired or may be inhaled from a suitable mouthpiece. Reports on the results obtained are favorable, and hitherto no ill effects have been observed as the result of its use.

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